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WANTED by Controlled Firm, Manchester District. Applicants should have held similar position, with experience on Turret Lathes and Gear Cutters, must be up-to-date in latest machine shop practice and able to turn out work quickly and accurately.—Apply, stating age, experience and salary required, to your nearest EMPLOYMENT EXCHANGE, mentioning No. A 4400. No person already on Government work need apply. K 36

Machine Shop Foreman

WANTED, for Works in Lancashire, manufacturing duplex pumps, hydraulic machinery and small high-speed engines. Permanent position for suitable man. No person already on Government work will be engaged.—Apply, stating full particulars of experience and salary required, to your nearest EMPLOYMENT EXCHANGE, mentioning No. A 4500. K 136

Foundry Foreman Wanted

immediately for London Ironfoundry; must be a thoroughly practical moulder with good general foundry experience and used to control men; good position for capable man. No one engaged on Government work or residing more than 10 miles away need apply.—Address, stating age, experience and salary required, K 138, Offices of ENGINEERING.

Foreman Wanted for Capstan

Section, for accurate repetition work—Aero and Aircraft parts; used to controlling female labour and getting maximum output. State experience and salary required—Clyde district—good opportunity for man with initiative. No person already on Government work will be engaged.—Apply to your nearest EMPLOYMENT EXCHANGE, mentioning this Journal and K 130.

Foreman Blacksmith Wanted,

experienced in Engine Forgings and Drop Hammer work. No one engaged on Government work will be employed.—Apply, stating age, experience and salary required, to your nearest EMPLOYMENT EXCHANGE, mentioning this Journal and K 145.

Assistant Foreman Required

by firm of Constructional Engineers, Roofs and Bridges, Tanks, &c.; must be well versed in Shop practice and essentially six o'clock man. State wages, experience, salary expected. No one already on Government work need apply.—Apply to your nearest EMPLOYMENT EXCHANGE, mentioning No. A 4456. K 146

Foreman Turner & Machinist,

West of England, WANTED, thoroughly competent man used to general and repetition work. Must be good disciplinarian and six o'clock man. No person already on Government work will be engaged.—Apply, giving full particulars of age, experience, salary, and if disengaged, to nearest EMPLOYMENT EXCHANGE, mentioning this Journal and A 4501. K 144

THE SCIOTOVILLE BRIDGE OVER THE OHIO RIVER.

MR. GUSTAV LINDENTHAL, NEW YORK, ENGINEER.

(*For Description, see Page* 81.)

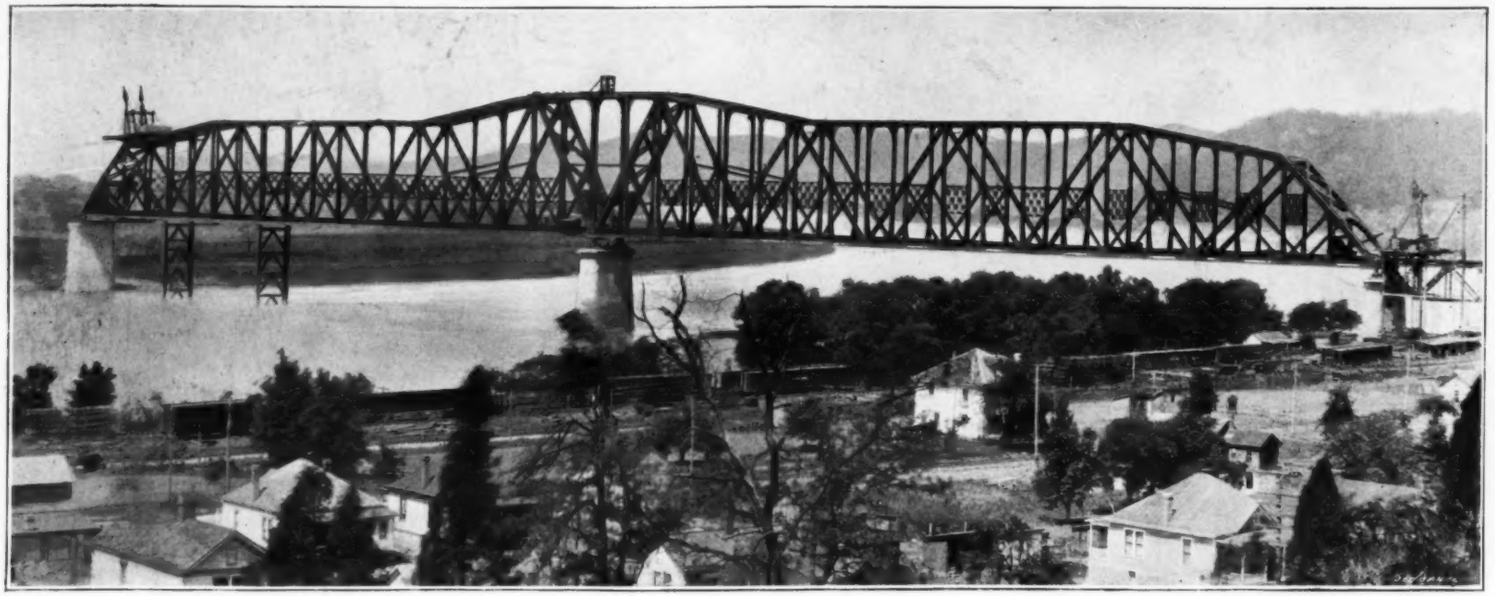


FIG. 1. VIEW TAKEN JUNE 7, 1917; BOTH SPANS COMPLETED, GANTRY TRAVELLER REMOVED, AND CREEPER TRAVELLER AT U 2, KENTUCKY SPAN.

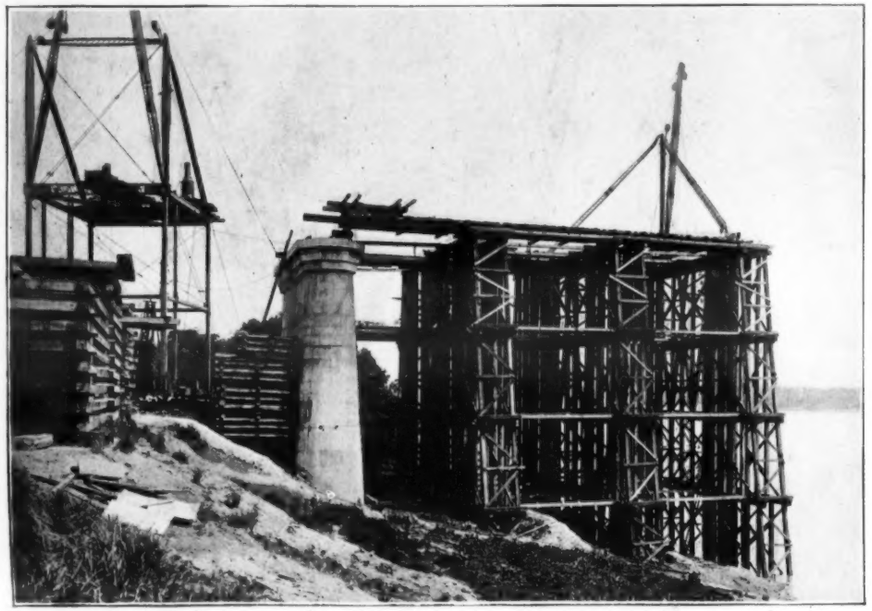


FIG. 2. FIRST THREE BENTS OF OHIO SPAN FALSEWORK.

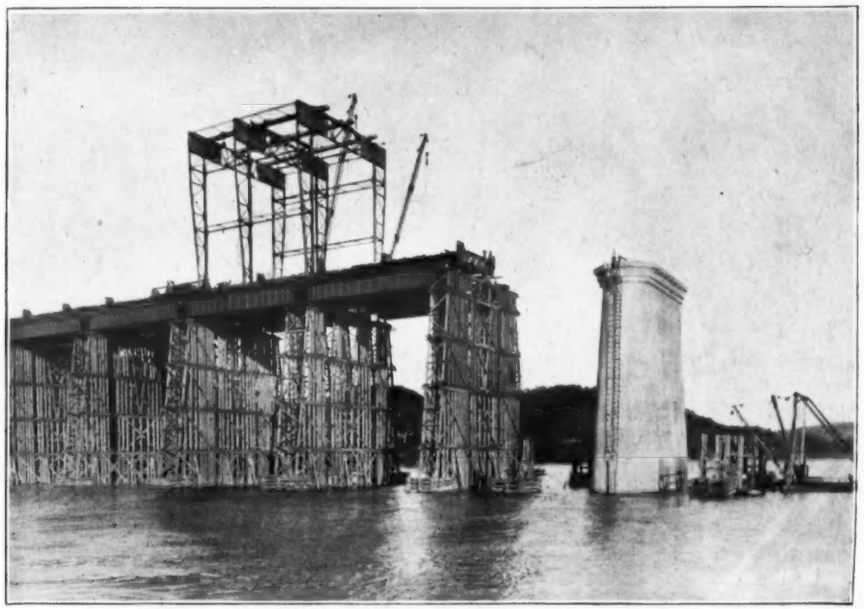


FIG. 3. INCOMPLETED GANTRY TRAVELLER ERECTING FLOOR SYSTEM OF OHIO SPAN. FLOATING DERRICK ERECTING LOWER STOREY OF FIRST FALSEWORK BENT FOR KENTUCKY SPAN.

Fig. 2. First Three Bents of Ohio Span Falsework.

Fig. 3. Incompleted Gantry Traveller Erecting Floor System of Ohio Span. Floating Derrick erecting Lower Storey of First Falsework Bent for Kentucky Span.

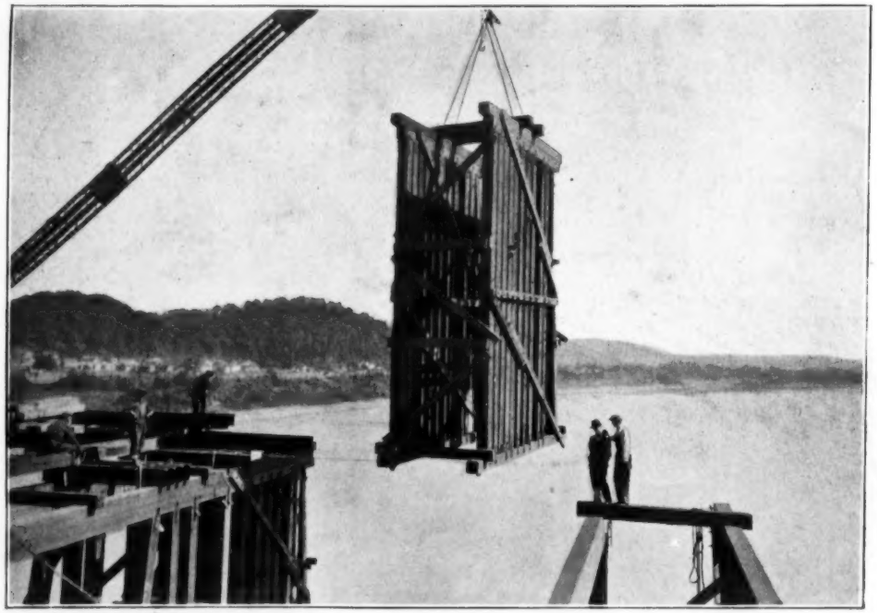


Fig. 4. Section Unit of Double Bent of One Storey of Falsework being Hoisted into Position.

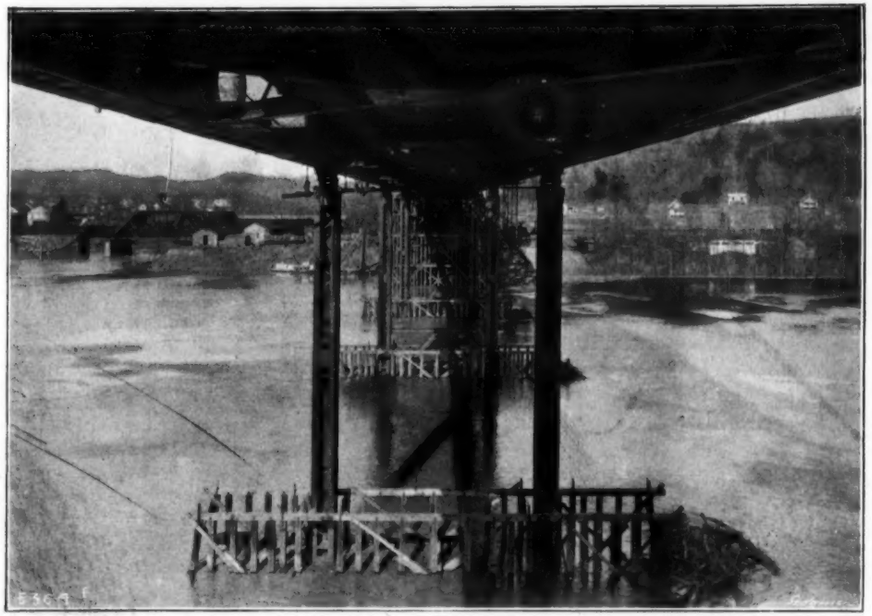


Fig. 5. View under Ohio Span after Removal of Part of Wooden Falsework; Steel Falsework in the Foreground.

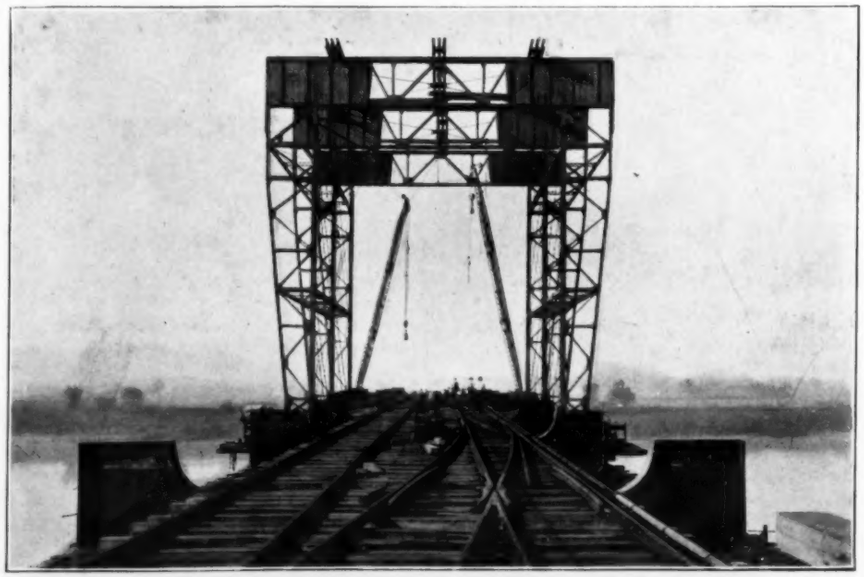


Fig. 6. Gantry Traveller as Used for Erection of Floor System with Transverse Girders and Jigger Beams at Low Elevation.

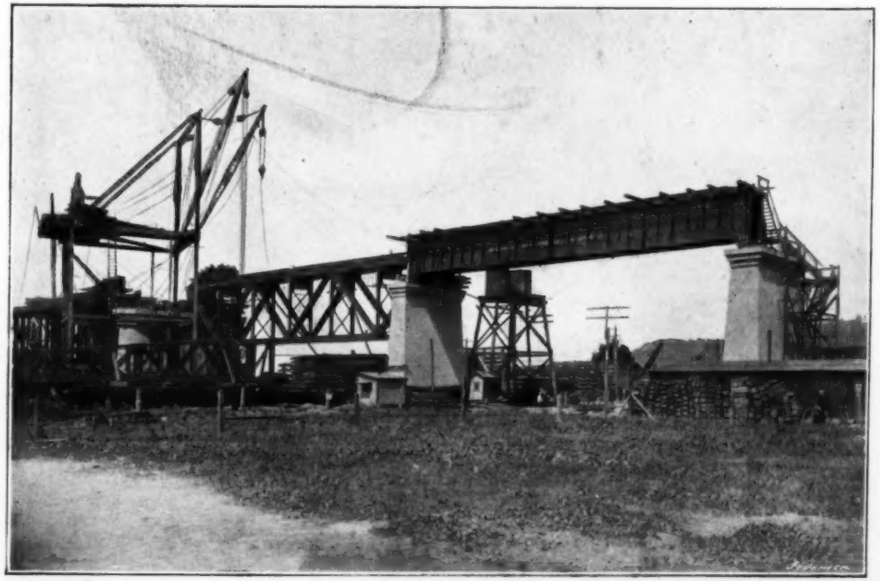


Fig. 7. Service Tower Erected. Approach and Plate Girder Spans on Ohio Side Supported on Temporary Cribbing.

THE SCIOTOVILLE BRIDGE.

By FRANK W. SKINNER, M.Am.Soc.C.E.

THE Chesapeake and Ohio Northern Railway crosses the Ohio River about 120 miles above Cincinnati, with the track at a clear height of 110 ft. above low water, and at a point where the river is subject to violent floods that may rapidly rise to a height of 40 ft., carrying great quantities of drift that imperil any permanent or temporary structures obstructing the channel and have wrecked many bridge spans during construction at other points on the river.

General Description of Bridge.—The bridge, which was designed by Mr. Gustav Lindenthal, consulting engineer, New York, has a total length of 3,435 ft. and steel weight of 15,000 tons, and includes a north approach 882½ ft. long and a south approach 1,062½ ft. long. Each shore approach is composed of a 152½-ft. riveted deck span adjacent to the river pier, and single-track deck plate-girder spans of 67½ ft. to 110 ft. supported on reinforced concrete piers which have been built for double tracks, although the viaduct superstructure at present installed is for a single track only, provision being made for the erection of the second track girders at a future period. The approaches are connected across the river by a continuous structure consisting of two 775-ft. spans united over the centre pier and supported on three concrete piers with foundations on solid rock, that not being subject to settlement, insure the maintenance of the assumed distribution of loads and stresses in the continuous trusses. The general view of the two spans completed, which is given in Fig. 1, Plate VIII, will explain the general design and render it more easy to follow the various stages of the erection which it is now our object to describe.

The main trusses are 129 ft. 2 in. high at the centre, 77 ft. 6 in. high at the end, and 38 ft. 9 in. apart on centres, and are of a single triangular type with horizontal bottom chords, horizontal and inclined top chords, with the principal web members two panels long and inclined approximately 45 deg. with the horizontal. These very long main diagonals are braced at the centre points by members which divide the trusses into uniform panels 38 ft. 9 in. long. The spans are the longest of their type ever built, and are made throughout with riveted members and with fully-riveted joints, except that they have pin bearings in pedestals on the end piers. They are the first long spans of this type, and have the longest and heaviest fully-riveted trusses in America.

The type was adopted after a comparative study of several designs, including successive single spans, cantilever trusses and continuous trusses, the latter showing not only a marked economy for the type selected, but also securing the advantage of a pleasing and symmetrical outline. Some unusual features were adopted in the development of the design, mainly to secure the greatest rigidity and the minimum of secondary stresses. No expansion joints are provided in the floor system, but the longitudinal stresses due to locomotive traction and train braking are transmitted to the lower chords through horizontal transverse trusses in each floor panel that prevent the development of bending stresses in the floor beams.

Details of Superstructure.—The inclined end posts are braced with solid plate-girder portal struts below and stiff diagonals above, and the vertical posts at main panel point are connected by one upper and two intermediate transverse struts, the former being knee-braced and the latter pair of struts being connected by a multiple system of diagonal members virtually forming with them deep traverse lattice girders. The usual top and bottom lateral systems of X-bracing in the planes of the upper and lower chords are provided.

The floor beams are of novel design, U-shape in side elevation, made up with a horizontal plate girder 7½ ft. deep, that is web-connected to the deep track stringers, 6½ ft. apart on centres. Just beyond the outer track stringers the top flanges of the floor beams are curved up and the bottom flanges are bent 45 deg., and the beams are spliced to the vertical solid web wings extending up to the lower transverse struts and riveted through their entire length to the inner vertical plates of the vertical posts, thus providing much lighter and stiffer members and permitting a shallower floor than would be the case with ordinary floor beams.

The bottom chords are of ordinary simple rectangular construction made up of two built I-beams with top cover plates and bottom channel latticing. The other principal members have similar sections or are made with pairs of built channels latticed or have I-sections with a solid web-plate and two pairs of flange angles. All of the secondary members are latticed on both sides.

The principal connections are made with pairs of heavy gusset plates with dimensions up to 140 in. by 1⅜ (four thicknesses) by 18 ft. 2 in., with field rivets up to 1¼ in. in diameter and 7⅛-in. grip. The heaviest chord member has a 48-in. by 54-in. cross-section and is 77½ ft. long, with a sectional area of 596 sq. in. and a weight of 176,000 lb. The heaviest web member has the same kind of cross-section, a length of 75 ft., a sectional area of 511 sq. in., and a weight of 180,000 lb. The heaviest casting weighs 45,000 lb. Each bearing on the centre pier has a dead load of 5,000 tons and a live load of 3,000 tons.

The bridge is made of structural steel with ultimate strength of 62,000 lb. to 70,000 lb. per square inch. The dead load is 18,800 lb. per lineal foot, and the live load was calculated for Cooper's standard E 60 loading on each track, with impact allowances I for each track according to Lindenthal's formula,

$$I = \frac{L^2}{D + L} \times \frac{1200 + \frac{a}{n}}{600 + 4a}.$$

L = live load stress.
D = dead loss stress.
a = length of train behind tender.
n = number of loaded railroad tracks on bridge.

The unit stresses are 20,000 on net sections of tension members and 20,000 reduced according to length ratio by a special table of net sections of compression members.

The bridge was designed by the elastic-curve method. In the preliminary approximate design the truss was treated as a beam with a constant moment of inertia. In the second design the first method was used with the influence of the web members neglected, and in the exact final design the effect of all members was included. A comparison of the area of the elastic curves of these three methods showed that the limit of error for the first assumption varied between plus 2 per cent. and minus 10 per cent., in the second approximation they varied between minus 1 per cent. and plus 4 per cent.

The superstructure was fabricated at the shops of the McClintic-Marshall Construction Company, contractor. The trusses were assembled in sections in normal position in the yard, and while assembled all connections were either drilled from the solid or reamed to insure perfect registration in the field.

General Method of Erection.—At low stages of the river the water in the centre of the channel and on the north or Ohio side is very shallow, and has no navigation, so that it was permissible to erect the Ohio span on falsework at every panel. The trusses were assembled by a steel tower traveller or gantry moving on track rails outside the trusses and clearing the highest point of the top chord. The erection of the Ohio span was first commenced and was completed in advance of the erection of the Kentucky span, so that it served as a counterweight for the Kentucky span during the erection of the latter as a cantilever.

As only the minimum obstruction was permissible in the Kentucky channel, the span over it was built by the modified cantilever method, except that the two panels nearest the Ohio span were built on falsework similar to that used for the latter. The Ohio falsework is shown in Fig. 2, Plate VIII, a movable stiff-leg erection derrick being installed. The raised sections of the falsework bents will be seen stored on the shore side of the pier. The remainder of the trusses of the Kentucky span were built as cantilevers, and to avoid the necessity of increasing the cross-sections of the members much above those required for working stresses in the finished bridge, and to keep down the erection stresses, the trusses were successively supported at two intermediate points between the centre-pier falsework and the Kentucky shore. At these points they were landed on steel rocker bents and the portions of the trusses on the Ohio side of these bents were successively transformed from cantilevers to continuous girders as bearings were established on these bents. This method of erection of course necessitated very accurate and elaborate investigations of the erection stresses and distortions of the members. The results of these computations and various actual deflection readings were plotted in order to determine the elevations and the reactions developed at the temporary points of support. After the completion of the trusses they were jacked up to release the temporary supports and transfer the weight of the superstructure to its permanent bearings on the Kentucky pier.

The cantilever erection was greatly facilitated and the stresses materially reduced by the special overhead erection traveller employed. It was a modification of the type previously and successfully used for erection of the Beaver Bridge, and was so light and efficient that it produced only a relatively small increase over the moment due to dead weight of the structure and was rapidly and accurately handled by a small-size crew of erectors.

Among the principal features of the erection work were the provision of separate systems of steel and wooden falsework for the support of the Ohio span and of the gantry traveller and service tracks respectively, the bearings of the trusses on the falsework, the provisions for camber adjustment and for lifting the trusses, the method of distorting the truss members to coincide with the positions of the no-stress diagram when assembled, devices for handling the long and heavy members, the support and protection of falsework footings, improved details of the traveller, and the provision of elevator hoists for men employed on the upper part of the structure.

Timber Falsework.—The falsework for the traveller track of the Ohio span consisted of steel beams and girders and wooden trestle bents that also supported the bottom chord and floor system carrying the service tracks until the steel weight was transferred to the steel falsework.

Pairs of falsework bents, 77½ ft. apart, were located at every other panel point, as shown in Fig. 3, Plate VIII, and two additional intermediate pairs of bents were located at panel points L–1 and L–3, and a supplementary bent was located at L–6. Each pair of bents were braced together longitudinally to form a narrow tower, and the four towers at points L–1, L–2, L–3 and L–4 were braced together with four tiers of longitudinal struts extended to bearing against the main pier at the Ohio end of the span and by sets of adjustable X-brace rods in the vertical panels between the longitudinal struts, thus forming a continuous trussed structure with great longitudinal rigidity and stability. There were six 10 in. by 10 in. full-length timbers in each tier of longitudinal struts, each of which was tapped and bolted to the bent at each end. The regular towers were 13 ft. wide longitudinally, but the intermediate ones at the Ohio end were only 9 ft. wide.

Lower Story of Falsework.—These bents were four stories high, the lower story about 91 ft. long, transverse to the bridge axis, consisted of a maximum of 27 vertical and 2 inclined 12-in. by 12-in. timbers, set on the clean and approximately level rock, and capped with 12-in. by 12-in. timbers spliced with pairs of bolted steel side plates. The caps were attached to the posts by pairs of standard vertical steel scab plates with two bolts through the pile and one bolt through the caps. Near the water-level they were braced by seven pairs of longitudinal struts and had six panels of X-bracing reaching from the caps to the longitudinal struts.

To increase the stability of the falsework and its resistance against the forces of the current and of drift and impact, the batter piles at the ends of the bents and the first vertical post adjacent to each batter post, were placed inside cribs set on the bottom and filled with broken stone. The cribs were built chiefly of round timber, laid up log-house fashion. They were made in two sections, each about 6 ft. high. They were floated to place, end-

wise, end bolted together, and both filled with stone and sunk in position as a unit. This work was done by a floating wooden derrick with a pair of 40-ft. timber booms.

Upper Stories of Timber Bents.—The upper part of each falsework bent consisted of three stories, respectively 25 ft., 21 ft. and 30 ft. high from the bottom up. Each story was made with full-length, 12-in. by 12-in. vertical and battered posts bolted at each end through steel scabs, like those of the lower story, to 12-in. by 12-in. caps and sills, and cross-braced with 4-in. by 8-in. diagonal struts each made with two overlapping pieces spliced together, one diagonal being placed on one side of the bent and the intersecting diagonal on the opposite side.

The upper three stories of the bents were framed on shore and were assembled in sections, the two corresponding sections of each pair of bents for each story being bolted up with their complete caps, sills and diagonals and bolted together by longitudinal, horizontal and diagonal pieces, thus forming a one-third section of one story of the tower, which was handled as a unit. Only one end of each diagonal brace was bolted before the bents were erected, thus allowing for plumbing them after erection.

These units were assembled on the Ohio shore close to the bridge, and were delivered to a hoisting tower about 40 ft. square and 60 ft. high made with four steel vertical-corner posts and adjustable steel diagonal rods.

A double stiff-leg steel derrick, with two 50-ft. booms of 50 tons capacity, was installed on top of the tower, and hoisted erection plate and steel bridge members to the service tracks on the bridge floor. These booms handled the falsework units, which were erected by a stiff-leg travelling steel derrick, with a 70-ft. boom of 15 tons capacity, that moved forward on the completed falsework. It was operated by a steam hoisting engine located on top of the tower, which, with the other tower engines, served as counterweights for the tower derrick. Fig. 4, on Plate VIII, shows a section unit of double bent of one story of the falsework suspended from the derrick ready to set in position.

Falsework Beam and Girder Spans.—At the shore end of the falsework the towers were connected by two groups of four I-beams supporting the permanent floor beams. Two other sets of parallel I-beams in the planes of the trusses carried the camber wedge jacks, and two sets of four plate girders each spanned from tower to tower for each of the two standard-gauge tracks for the erection travellers, where the towers were one panel apart.

The spans, of about 60 ft. in the clear between the regular falsework towers in the river were bridged by plate girders temporarily borrowed from the approach viaducts at the ends of the bridge. These were seated on the caps of the falsework towers and the spaces of about 10 ft. between the ends of the adjacent spans were bridged by short longitudinal I-beams connecting the main girders. Two of these girders supported the floor beams at intermediate panel points.

The floor beams were supported 9 ft. 9 in. each side of the centre line on timber blocking placed on the longitudinal I-beams. The bottom chords of the trusses were supported on cast-steel wedge jacks operated by screws that were used by the contractor for the erection of the massive Panama Canal lock gates. The ties of the traveller tracks were supported directly on the top flanges of the longitudinal girders. The floor beams and lower chords were first set on blocking high enough to allow for the settlement of the falsework.

Steel Falsework.—The trusses of the Ohio span were also supported on four steel falsework bents located at the main panel points 4, 8, 12 and 16. A view of these steel bents is given in Fig. 5, Plate VIII. Each steel falsework bent consisted of two columns braced together transversely. The columns were erected between and cleared the timber falsework bents, each column had a 4-ft. 2-in. by 4-ft. 6-in. H-shape cross-section made of three built I-beams, 100 ft. long, fabricated in three sections. The cross-sectional areas varied from 159 sq. in. to 214 sq. in. The heaviest column was proportioned for a maximum load of 1,907,000 lb. from the truss, 135,000 lb. from the erection traveller, and 1,020,000 lb. from the wind stress. The wind stresses were derived from an assumed pressure of 27 lb. per square foot on both bridge trusses.

The tops of the falsework columns at panel points 8 and 4, Kentucky span, were pin-connected to horizontal, longitudinal struts which engaged knee-braced brackets at the next panel point of the lower chord until the truss weight was transferred to them.

The lower ends of the vertical columns were pin-connected to riveted pedestals anchored to concrete piers. The upper ends carried a pin-connected shoe and pedestal engaging the lower side of the bottom chord, with provision for two 200-ton hydraulic jacks on each side of the pedestal. The columns were assembled, reamed, and match-marked at the bridge shop, and the steel splices were made with 1-in. turned bolts.

To make the steel falsework bents independently stable, during their erection, vertical tiebolts were provided connecting the columns to their pedestals. This arrangement is shown in Fig. 8, annexed. When these bolts were removed the columns were transformed from square-ended to pin-ended and the bent became a true rocker bent.

Gantry Traveller.—The Ohio span and two panels at the Ohio end of the Kentucky span were erected by a gantry traveller formerly used on the erection of the Beaver Bridge, described in ENGINEERING of January 17, 1913, and modified for the erection of the Sciotoville Bridge. As used here, this traveller, which will be seen in its incompleted condition in Fig. 3, on Plate VIII, had an extreme height of about 163 ft. an overall length of 77 ft., and an overall width of about 75 ft. It was made with three vertical bents with an inside clearance of about 50 ft. horizontally, and a vertical clearance of about 150 ft. above the rail, enabling it to move back and forth over the finished structure.

Each bent was composed of two vertical trusses, each seated on two double-flange wheels and connected at the upper end by a lattice girder 10 ft. deep, with solid plate webs in the end panels. The bents were braced longitudinally by horizontal struts and pin-connected adjustible diagonal rods. The transverse trusses were connected by three sets of three longitudinal jigger I-beams each that were seated on the top flanges on the centre line of the bridge and in the planes of the trusses, and by pairs of longitudinal struts 10 ft. apart between the vertical legs. The panels between the pairs of longitudinal struts contained diagonal rod bracings.

The longitudinal jigger beams (see Fig. 6) served as lifting girders, from which 50-ton tackles were suspended in the planes of the bridge trusses and 35-ton fleeting tackles were suspended from the I-beams on the centre line of the bridge.

Traveller Rigging.—The traveller was equipped with two steel derrick booms, 80 ft. long, of 15 tons

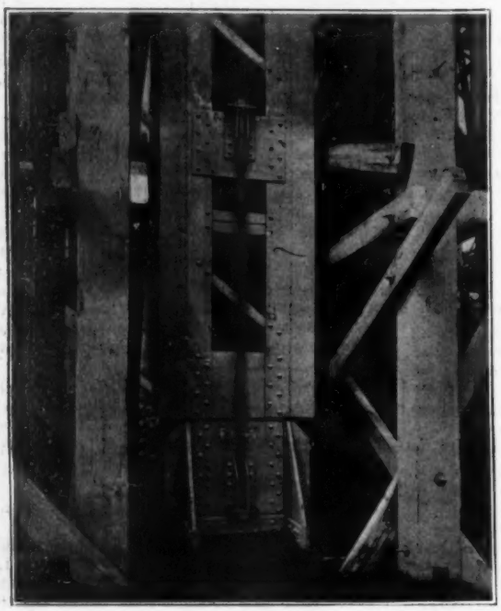


FIG. 8. BASE OF FALSEWORK TOWER NO. 4. OHIO SPAN. FOOT OF STEEL FALSEWORK COLUMN TEMPORARILY ANCHORED TO PEDESTAL.

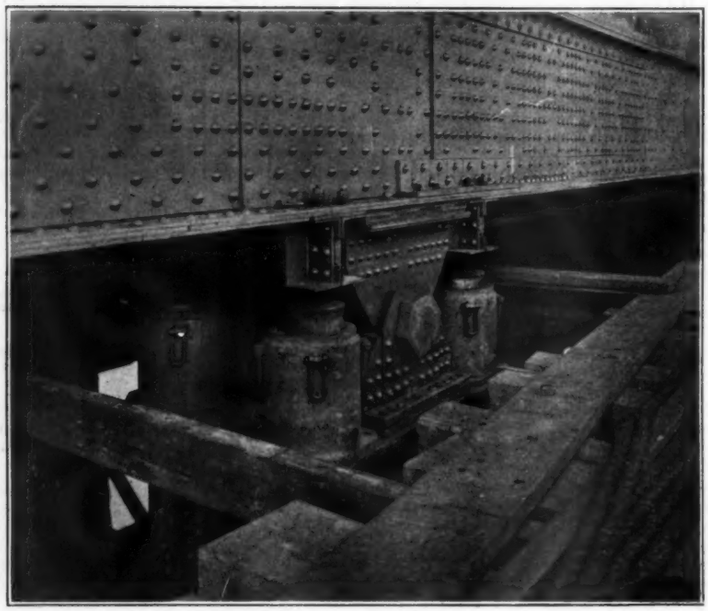


FIG. 9. HYDRAULIC CAMBER JACKS AND PIN BEARING FOR BOTTOM CHORD ON TOP OF STEEL FALSEWORK COLUMNS L 16, OHIO SPAN.

capacity, connected to the feet of the forward transverse bent. The hoisting and topping lifts of these booms were operated by ordinary electric hoisting engines, and the derricks were swung with bull wheels operated by tackles commanded by pairs of electric derrick-swinging engines. These booms were used only for the erection of the falsework.

The traveller was also equipped with six tackles of 50 tons capacity and two fleeting tackles of 35 tons capacity, and was usually operated by a gang of about 20 men. The tackles were operated by three electric hoisting engines, and the heaviest piece lifted weighed 90 tons. The traveller and equipment weighed 200 tons, and its best record on this work was the erection of 500 tons of bridge steel in 10 hours.

Erection of the Ohio Span.—The erection of the Ohio span was commenced by the assembling and connection of the floor beams, floor stringers and lower chords for the full length of the span. Service tracks were laid on the permanent floor, as shown in Fig. 6, Plate VIII, and the truss members delivered by the service tower on shore at the end of the span were brought to the gantry traveller, which hoisted them and held them in position until their connections were made and they were independently stable. Fig. 7, Plate VIII, shows the service tower erected and the approach and plate girder spans on the Ohio side supported on temporary cribbing.

The floor system and bottom chords were extended to L–18 of the Kentucky span* and the erection of the trusses was commenced at L–18 of the Kentucky span and completed to L–18 of the Ohio span, and continued to L–16 of the Ohio span before the erection of the Kentucky span was commenced, after which the erection of the Ohio span was completed by the gantry traveller before the erection of the Kentucky span had proceeded beyond panel point L–17.

After the splices of the lower chord were riveted, the chords were jacked to positions on a curve, varying from 1¼ in. above to 8 in. below the level line in order to provide for the easiest connection of the web members. This curve and other curves showing the position of panel points under different conditions of loading were very carefully laid off on accurately-computed deflection diagrams, by which the amount of jacking and the resistance developed were indicated. A view of the hydraulic camber jacks and pin bearing for the bottom chord on the top of the steel falsework columns at L–16, Ohio span, is given in Fig. 9, on page 82. As soon as the trusses were assembled sufficiently for their supports to be transferred from the wooden falsework to the steel falsework bents the timber falsework towers were all removed, starting from the Kentucky end.

Some of the connections of the web members to the top chords could not be made without forcing, because the members were finished according to the dimension given by the assumption of full dead load and half live load (3,000 lb. per lineal foot) per truss. Usually the web diagonals were bent upward by the traveller tackles and held there until drift pins could be entered in the field rivet holes and the connections drifted to position, producing a slight reverse bend in the members.

(To be continued.)

* The "spans" of the panels were numbered from the two shores to the centre pier, where the Ohio span 20 and the Kentucky span 20 meet. The letters L and U used in the description refer to the lower and upper chords.

BICENTENARY OF D'ALEMBERT (1717–1783).

TEN years ago when sketching the life of Leonard Euler we quoted the words of Nichol, the Glasgow professor of astronomy, to the effect that "In our own modern times there are three great and classic epochs as to mathematical science. The first was filled by the achievements, the fame and the power of Newton, Leibnitz and the Bernoullis. Following them we have the great triumvirate, Euler, D'Alembert and Clairaut; to which succeeded the reign of Lagrange and Laplace." Of these illustrious men, Euler was born in 1707, Clairaut in 1713 and D'Alembert in 1717. Clairaut died in 1765, while Euler and D'Alembert died in 1783, within six weeks of each other. If it were our purpose, an interesting picture could be drawn contrasting the lives and characters of these two men who, each in his own sphere, produced lasting effects on the progress of mankind, the one by his purely mathematical work and the other not only by his scientific work but by his spirited independence of thought and action. Euler's life at St. Petersburg and Berlin was devoted almost entirely to the exact sciences, and he had little of the disposition of a Voltaire or a Huxley. D'Alembert, on the other hand, after raising himself to eminence as a mathematician, turned to the fields of philosophy and literature, and played a leading part in the emancipation of men of letters from the thraldom of patronage.

The name Alembert, or D'Alembert, was an assumed one, for this distinguished Frenchman started life as a foundling—an illegitimate child exposed when but one day old on the steps of the church of St. Jean le Rond, which in those days nestled under the great porch of Notre Dame, in Paris, and being taken before the parish commissary, he was placed in the charge of the wife of a poor glazier and given the name of Jean le Rond. His father turned out to be one, Destouches Canon, a provincial commissionaire of artillery, while years afterwards he was claimed as a son by the famous society beauty Madame de Tencin, the friend of Fontenelle, of Montesquieu and other prominent men. The relations of D'Alembert with his foster-mother were, however, always very happy, and he spent the first forty years of his life under her roof. From the first his father provided for his immediate needs by settling an annuity of 1,200 francs upon him, and though in after life he received the small pay of an academician and accepted a pension from Frederick the Great of Prussia, generosity was ever a marked characteristic with D'Alembert; he cared little for money or for the pleasures money could buy. Sent, when a boy, to the College of the Four Nations, he early gave signs of great intellectual gifts, and, finally, after studying law and medicine, he returned to his first love of mathematics, gave up prospects of fortune and contented himself with his freedom, his annuity and his simple life with Madame Rousseau, the glazier's wife. The results of his labours were given to the world in his essay on the integral calculus (1738), his treatise on dynamics (1743), his treatise on fluids (1744), and his "Theorie General des Vents" (1745). These were all important works, and his volume on dynamics, coming as it did at the end of the long controversy on moving forces which had occupied the thoughts of mathematicians for thirty years, marked an epoch in the treatment of mechanics. The well-known principle of D'Alembert was stated by Rankine thus: "If from the forces impressed on any system of bodies connected in any manner there be subtracted the forces which, acting alone would be capable of producing the actual acceleration and retardation of the bodies, the remaining system of forces must balance each other." In 1747, D'Alembert, with Euler and Clairant, was a competitor for the prize of the Paris Academy of Science for an investigation of the irregularities of Jupiter and Saturn, and two years later he published his work on the Precession of the Equinoxes, which contained a rigorous investigation of the motion of the earth about its centre of gravity. His treatise on the resistance of fluids appeared in 1752, his researches on the moon's libration and some lunar tables in 1754, and with this may be said to end his purely mathematical work. Chosen a member of the Academy of Sciences in 1741, when 24 years old, he was admitted to the French Academy on December 19, 1754, when he read to the Academy the preliminary discourse of the famous "Encyclopædia" projected by Diderot. He became secretary to the Academy in 1772, and among his writings were the eloges of nearly seventy deceased members of that body. From 1754 onward, philosophy, history, literature, music and other subjects claimed his attention; he frequented the brilliant society of that time, and was recognised as one of the leading men of his day. Of his "Essay sur la Société des gens de lettres avec les grands," Condorcet maintained that it had a large share in promoting the independent spirit and position by which men of letters became distinguished. Of an amiable disposition, his character was bold and frank, and he enjoyed the friendship of such as Borda, Lagrange, Voltaire and Rousseau. Though never married, he was affectionately attached to Mademoiselle de l'Espinasse, and though he lived for several years in the same house as this lady, no scandal attached to his name. He died in Paris after a tedious and painful illness, on October 29, 1783.

D'Alembert's life not only corresponded with one of the most remarkable periods in the intellectual life of France, but it coincided with the rise of a great school of physical enquirers, probably the most brilliant group of mathematicians, astronomers, chemists and physicists the world has ever seen. And in this connection it is not without interest in these days, when the respective contributions of the various nations towards the development of scientific knowledge are so often discussed, to make a brief survey of the history of the sciences and recall a few notable facts. The revival of learning in the fifteenth century extended to all branches of literature as also to mathematics and astronomy. The invention of printing (1440), the fall of Constantinople (1453) and the coming of the Reformation all assisted in the revival of an interest in the material world, and modern science may be said to date from 1453. At the sack of Constantinople in that year by the Turks, many of the monks living there fled westward, carrying with them the precious manuscripts of the ancients and others, and thus though no Turkish name is found in our histories of science, this race of military conquerors contributed indirectly to the spread of knowledge. The manuscripts, by force of circumstances, passed into Italy and Germany, and it was there that the first translations of Euclid, of Ptolemy, of Apollonius and others were made. The sixteenth and seventeenth centuries reaped the harvest thus sown, and we see the rise of Copernicus and Kepler in Germany, then that of Galileo in Italy, and of Newton in England. The centre of gravity of scientific thought, as it were, thus shifted from Germany to Italy, from Italy to England. In the eighteenth century, owing to various causes, among which was the adoption of Leibnitz's notation of the differential calculus, the pre-eminence in mathematical matters passed to France, which retained the lead undisputed for many years. Among mathematicians, Clairaut, Montucla, D'Alembert, Borda, Vandermonde, Lagrange, Monge and Laplace were all born within the first half of the eighteenth century, as were also the astronomers Lacaille, Lemonnier, Messier, Lalande, Bailly, Delambre and Mechain. No other country can recall any list of contemporary names of nearly equal distinction as these. Euler and Daniell Bernoulli appeared in Switzerland, Riccati, Boscovich and Agnesi could be claimed by Italy, and England could boast of the birth of Simpson and Maskelyne, of Landen and Waring. In Germany, the comparative deficiency in great men is very marked, for she saw during this time the birth of but one astronomer of note—Tobias Mayer—and of Kaestner and Lambert, among mathematicians. We ought, perhaps, not to omit the name of William Herschel, who, it is right to remember, was a German by birth and breeding. Though appreciated by students of history, it is not generally recognised what a burden was left the German States by the Thirty Years' War (1618–48). This awful struggle held the country in its vicious embrace for more than a quarter of a century, laying waste wide districts, impoverishing and decimating the population, and throwing back the spread of intellectual culture for many years. The more deeply the course of the seventeenth and eighteenth centuries is studied the more deeply the mind is impressed by the awful and melancholy nature of the calamity suffered by the inhabitants of the German States, a calamity which, says Ambassador Gerard, in his recently-published book, affects the thoughts and spirits of the German people to-day. And nowhere are the unhappy results of this struggle more evident than in the story of the progress of science. During the century 1650–1750 it may be doubted whether the total contributions of Germany to science equalled

in value the work of, say, Huyghens. There is but one outstanding name—that of Leibnitz—but his great invention of the differential calculus was due to his contact with men of science of Paris and London, and cannot be traced to any inspiration he received at home. In the great scientific movements of the day Germany had but a small part. True, we owed to her the introduction of the air pump, the friction electric machine and the mercurial thermometer, but she made no contribution compared with the enunciation of the law of gravity or the discovery of the composition and the velocity of light. Also the enunciation of the undulatory theory was due to Huyghens, and the principal contributor to the extension of our knowledge of the heavenly bodies was Cassini. The expeditions to determine the shape of the earth, the development of the chronometer and the attempts to determine the longitude at sea, the development of mechanics and the establishment of great national astronomical observatories saw no rival achievements in Germany. The transactions of the Royal Society of London and of the Paris Academy of Sciences reflect the scientific activities of the British and French nations, but it is a strange commentary on much that is advanced by some of the German intellectuals to-day that the most valuable memoirs in the proceedings of the Berlin Academy of Sciences during the eighteenth century were those contributed by foreigners.

The recovery of Germany from this relapse was well advanced by the time of Goethe and Schiller, and during the last century she attained once more to her true position of equality with the other Western nations. There has, however, been a tendency to draw a distinction between the scientific work of the Germans and of others, and to find it lacking in brilliancy or inspiration—to find that they follow where others lead. Such a conclusion does not appear warranted, and it would be a mistake if this opinion became general. If it were possible to evaluate and integrate the contributions of this or that nation to the sum total of knowledge, what would be the gain? Kepler, Galileo, Newton, Lavoisier, Huyghens, Berzelius, Faraday, Helmholtz, Reamuur, Pasteur and Kelvin are the heritage of the world, and to this list might be added, did we hold a brief for Germany, Gauss, Bessel, Olbers, Struve, Hansen, Argelander, Jacobi, Pfaff, Weber, Hertz, Mitscherlich and Bunsen. It was the American, Gould, who described the Russian observatory at Pulkowa as the astronomical capital of the world, yet was it not the genius of a German family which raised it to that position? Who would choose to place in the balance the respective merits of Wöhler and Dumas, of Liebig and Fremy? Almost without exception the English physicists and chemists of the latter part of the reign of Victoria were men who had eagerly sought admittance to the laboratories of Bunsen and Liebig, of Kirchhoff and Magnus. Were not the discoveries of Mansfield and Perkin the results of their contact with August Wilhelm Hofmann, to whom more than any man English chemistry owes whatever success has been hers? The estimation in which former German scientists were held may be illustrated by one or two facts. Of the first fifty annual medals of the Royal Astronomical Society one went to America, one to France, three to Italy and sixteen to Germany. Again, the highest honour France can show a man of science is to elect him a foreign associate of the Institute. Limited till recently to eight, this group of distinguished men—in 1870—just prior to the Franco-Prussian War—contained three Englishmen, one Swiss and four Germans. It is also worth recalling that of the eminent men chosen to deliver the Faraday memorial lectures to the Chemical Society, one has come from Russia, one from Italy, one from America, and four have come from Germany. The records of the Royal Society are equally interesting in this connection. Many wars have been waged since the days of Copernicus, but the historics of astronomy, of mathematics, of physics and chemistry have little to say of emperors or kings, statesmen or soldiers. It is, however, clearly seen that when ever national jealousies, prejudices and hatreds have appeared the result has been a hindrance and not a furtherance of true progress. The result of our wars with Napoleon, Mr. Edmund Gosse said the other day, was that "the average Frenchman believed the English to be a nation of dreary hypocrites; the average Englishman believed the French to be a race of dissolute Atheists."

"The world is not for aye; nor 'tis not strange
That even our loves should with our fortunes change."

However deep our abhorrence of the principles and practises of the present rulers of Germany, there is no more to be gained by decrying the work of her astronomers and chemists than in refusing to listen to the magic of her composers.

"All civilised nations," wrote von Zittel twenty years ago, "have shared in the development of the natural sciences, the history of any one of which must be to a certain extent the history of a scientific freemasonry," and this freemasonry of science has never found a happier demonstration than at the annual dinner of the American Institute of Electrical Engineers in 1901, when the toasts honoured were to "The Land of Ampere," "The Country of Faraday," "The Successors of Ohm," "The Heirs of Volta," and "The Legatees of Franklin."

THE ECONOMICS OF THE CHINESE RAILWAYS.

THE war in Europe has undoubtedly set back the development of China for many years unless the Government can gain the confidence of the people and foster some spirit of patriotism. China at the outbreak of the war was committed to the construction of some 6,300 miles of railway, practically all of which was to be built by foreign loans. Had this scheme been carried out the very slow development of the country would have made great strides. As it is, the country is nearly bankrupt, the Government insecure and without the confidence of the country. The people as a consequence are very chary of investing in Government controlled concerns. It is fairly obvious that China must still look for money abroad, and there is very little doubt that it will be more costly than heretofore. Consequently the study of economy will be more of a necessity than it has been in the past. Various savings would perhaps result from variations in the present methods and standards of construction, but before entering into a discussion of this a short summary of the railway needs, resources and present conditions of transport in the different provinces would perhaps be useful. The estimated populations of the 18 provinces of China proper, together with their areas, are given in the following table:—

Province.	Area, Square Miles.	Population.	Number to Square Mile.
Anwei	48,461	20,596,000	425
Chekiang	39,150	11,589,000	296
Fukien	38,500	22,199,000	574
Honan	66,913	22,115,000	340
Hunan	74,320	21,002,000	282
Hupeh	70,450	34,244,000	486
Kansu	45,450	9,285,000	74
Kiangsi	72,176	24,534,000	340
Kwangsi	78,250	5,858,000	65
Kiangsu	44,500	20,905,000	470
Kwangtung	79,456	29,706,000	377
Kweichow	64,554	7,669,000	118
Chili	58,940	17,937,000	304
Szechuan	116,800	67,782,000	406
Shansi	56,258	12,211,000	221
Shantung	53,762	36,247,000	557
Shensi	67,400	8,432,000	126
Yunnan	10,706	1,721,000	108
	1,335,841	386,000,000	292

It will be seen from the above table that the bulk of the population is concentrated in the following provinces:—Anwei, Honan, Hupeh, Chili, Shantung, Kiangsu and Northern Chekiang. These provinces form what is known as the Great Plain of China, which is shown in the heavy dotted line in the accompanying map.

Roughly, the area of this plain is 210,000 sq. miles, with a population of 132,000,000, or 625 persons to the square mile, the densest in the world.

Fig. 1.

In fact, the nine eastern provinces in or near the Great Plain have an area of 502,192 sq. miles. (two-fifths of the whole 18 provinces) and an average population of 458 persons to the square mile.

The necessity of railways for the development of this area is extremely obvious when its mineral wealth, cheap labour and present lack of transport facilities are considered. Practically the whole of the western portion of this plain is one vast coalfield, with smaller coalfields in central Shantung and northern Chili. Other minerals, ironstone in particular, are also present in large quantity on the eastern boundary. The mineral and other resources, agricultural and transport, are as follows:

Chili, the metropolitan province, has an area of 58,949 sq. miles. It produces wheat, maize, oats and salt, and is also responsible for a large proportion of the coal production of China. It is served by the Peking Hankow (No. 13), Peking-Mukden (No. 5), and Peking-Kalgan (No. 8) Railways, the Peking-Mukden Railway providing its outlet to the sea *via* Tientsin and the Peiho.

This river, the only one of importance, is navigable for steamers drawing 15 ft. of water as far as Tientsin, 40 miles from its mouth. This port is kept ice-free in mild winters at considerable expense, but is always liable to be closed from December to March on account of ice. The Peiho is tortuous, has a bar at its mouth, and is continually silting up. Most of the coal produced is shipped through the ice-free port of Chingwangtao, the property of the Chinese Engineering and Mining Company, whose accommodation for shipping has been designed with a view to their own requirements only.

Shantung has an area of 65,104 sq. miles. It is extremely fertile. Cotton, the clothing of the people, silk, straw-braid, glass, earthenware and bean oil, are some of its products. It has considerable mineral wealth, producing a fair quantity of coal, some gold and copper.

This province prior to the war was the German sphere of influence and has been exploited with the usual thoroughness. It is served by the trunk line from Tientsin to Pukow (No. 9 and No. 10), and has rail connection with the excellent once-German port of Tsingtau. All the railways were either German owned or under German control. Internal water communication is very poor. The province is traversed by the Grand Canal, which runs from Tientsin to Hangchow, but this in some places has been allowed to silt up and is generally in poor condition, and of little use as a waterway. The Yellow River, the only one of importance, is only navigable in parts, for small steamers as far as Tsinanfu, the provincial capital, 200 miles from the mouth of the river. This river owing to its tendency to silt up and burst its banks is of more expense than utility, costing the Government about 750,000*l.* per annum for conservancy. A railway along its banks for efficient handling administration of the conservancy works would appear to be one of China's most urgent needs. All railways and mines in the province are now worked by the Japanese.

Honan has an area of 66,913 sq. miles and is extremely fertile. Its principal agricultural products is beans, and a large amount of coal is produced. It is served by the Peking–Hankow (No. 13) Railway, which provides its outlet to the sea *via* Hankow and the Yangtse River. It has also another outlet to the same river *via* the Huai River and the Tientsin–Pukow (No. 10) Railway, but this route, which would serve much of Central Honan and Northern Anwei, is at present undeveloped, only junks of 80 tons maximum carrying capacity at present using this river.

Anwei has an area of 48,461 sq. miles, and is said to be the poorest province in China. It has never got over the devastating effect of the Taiping rebellion of 1866, and is in more of an arrested state of development than the other provinces of the plain. It produces tea, hides, rice and silk, and has deposits of coal and copper which have not been developed. The province is served by one line of railway, the Southern Section (No. 10) of the Tientsin–Pukow Railway, which is a British-built line. Water communication is poor, the only navigable rivers being the Yangtse and the Huai, the latter providing the only outlet to the sea for the northern part of the province *via* the above railway. This last river, and lack of maintenance on the Grand Canal, have been responsible for a series of most disastrous floods and their attendant famines. To properly conserve this river is one of the most urgent needs of the province, both for the above reason and because the usefulness of the river below its junction with the railway is very limited at present, as it loses itself in the very extensive but extremely shallow Hungtse Lake.

Kiangsu and Chekiang have an area of 45,000 sq. miles and 39,150 sq. miles respectively, and they produce beans, silk, tea and salt, among other things agricultural. Minerally these provinces are of small value. There are practically no railways within this area except the Shanghai–Nanking (No. 20) Railway in Northern Chekiang, whose usefulness is very limited, as it can never compete with a magnificent waterway like the Yangtse, with which it runs practically parallel. At present this line is merely a link in the trunk system and can only prosper when feeder lines are built. These provinces have, however, a most wonderful system of canals, of which there are some 50,000 miles. In addition, they are traversed north and south by the Grand Canal, and east and west by the Yangtse River, so that there is no very crying need for railways in this section of the country.

Hupeh has an area of 70,450 sq. miles, and produces tea, hides, iron and coal. It is served by the Peking–Hankow (No. 13) Railway, which provides its outlet to the sea *via* the port of Hankow and the Yangtse. Water communication is indifferent, the only navigable rivers being the Yangtse forming the southern boundary of the province and the Han River, a tributary, flowing on a northerly direction from Hankow. This province is in the centre of the modern iron industry of of China and should, if properly developed, be of huge importance in the opening-up of the country.

From the above very summary details it is obvious that the resources of this area are enormous, and that communications are extremely poor. The provinces are like watertight compartments as far as communications are concerned. At present there may be famine in one and excess in another, and no attempt is made to manufacture for more than local needs.

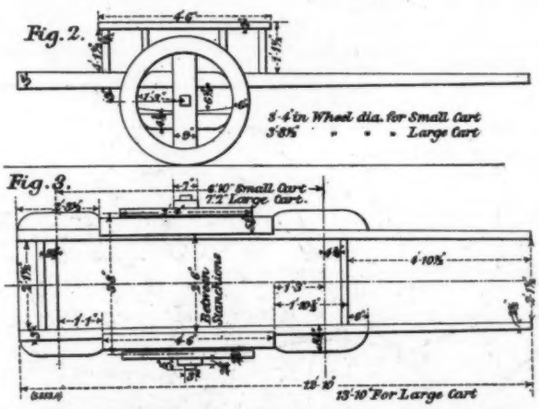
The railway situation in China can be summarised thus. With some 6,000 miles of railway in operation China proper has 0.3 miles of railway to each 100 sq. miles and 0.19 miles for each 10,000 people. For comparative purposes the United States has 238,356 miles of railway and 1 mile to each 370 people, Australia has 1 mile of railway for each 250 people, and the United Kingdom 1 mile to each 11 sq. miles. If the length of railway is summarised for the areas under consideration it will be found to amount to 2,679 miles, or 1 mile for each 127 sq. miles of country.

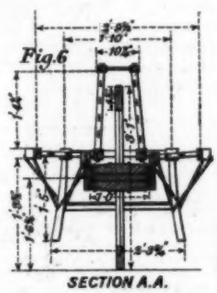
Water transport within this area is practically confined to the Yangtse River, which forms the southern boundary of the plain. This river, as far as Hankow, 600 miles from the mouth, is navigable for ocean-going steamers. The great drawback to the river is the enormous variation in the summer and winter levels, amounting to as much as 40 ft. at Hankow, and rendering navigation above this place difficult at low water. Above Hankow, in addition to the lack of water between Hankow and Ichang, there is also this difficulty coupled with the existence of rapids. However, small river steamers run between Hankow and Ichang all the year and between Ichang and Chunking when water permits; usually the river is closed from December to April. Ichang is 970 miles from the mouth of the river and Chunking about 1,400 miles.

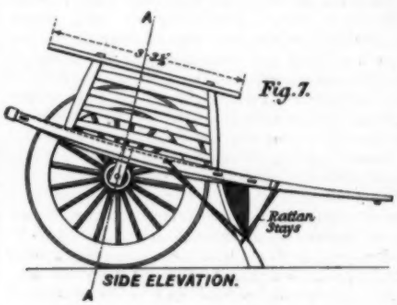
This handicap makes a railway connecting Hankow and Chengtu, the capital of the enormously populous and rich province of Szechuan, one of the most urgent needs of the country. Another railway of some urgency is a line through the province of Shansi and Shensi (No. 49) to the capital of the isolated province of Kansu. All these provinces are said to be very rich minerally, but owing to lack of transport have no chance of development.

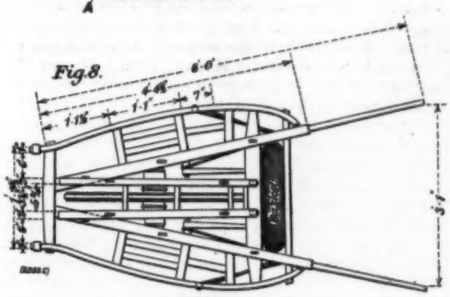
South of the Yangtse the country, with the exception of the province of Fukien, is less populous and much more mountainous. Railway construction would therefore be more expensive, and is less needed, as the bulk of the wealth and population is concentrated either on the southern side of the Yangtse Valley or on the seaboard where there is water communication. China should, therefore, concentrate on the Great Plain, the development of which will entail least investment of much-needed capital and offers more certain returns than elsewhere.

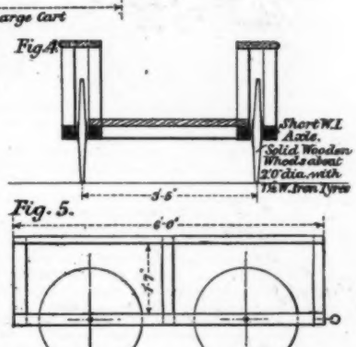
One form of transport has been altogether neglected in the above summary, namely, road transport, which is of very little value owing to the neglected state of the roads. There are said to be 2,000 imperial roads in China, but with the exception of the courier roads these highways are mere tracks or footpaths. The chief roads radiate from Peking, connecting that place with the various provincial











capitals. In some places these roads are paved with stone blocks of large size, and the ruins of signal towers and military posts at fixed intervals show that at one time some importance was attached to them.

The upkeep of the roads is at the present time in the hands of local officials, each village taking responsibility for its own roads. Only what are considered, according to local ideas, necessary repairs, are undertaken, with the consequence that no real road maintenance has been done for some centuries. The roads as built are unmetalled, and the bridging scanty, so scanty in fact that the majority of bridges have only been designed to take the dry-weather flow, with the consequence that for most of the year the approaches are flooded. In addition, where country of any difficulty has been encountered the road has degenerated into a mere footpath capable of taking only wheelbarrow, coolie or mule traffic, so that all cart-borne goods have to be transhipped.

On all these so-called roads in the plain goods are circulated by mule wheelbarrow or carts, but transport is rendered difficult and often impossible by the state of the roads, which are purely of the dry-weather order. Mule, donkey and wheelbarrow transport are universal all over China, but the cart is only met with north of the Yangtse, with the consequence that the roads in South China have degenerated into tracks of footpath width. The cart usually seen in North China is shown in Figs. 2 and 3; into this the farmer will put a load of 1 ton to 1.5 tons, or rather more than is put into the English cart, which has a tyre width of 5 in. against 2 in. in the Chinese cart. That roads in a country with 30 in. or more of rain per annum become impassable in the wet season is not to be wondered at, when their unmetalled state, their poor drainage and the traffic they carry are considered. North China has the great advantage of so severe a winter that even these roads would take the heaviest traffic, but this only holds from December to March, for the rest of the year the roads are as much dependent on weather for their usefulness as the rest of the country.

In the southern part of the Great Plain the cart is as shown in Figs. 4 and 5; it is pulled by a trace, and carries the same loads as the northern cart, but has even narrower tyres in a district with about twice the rainfall of the north. The wheelbarrow shown in Figs. 6 to 8 is even more destructive of roads, as it is, as often as not, unevenly loaded, causing the wheel to tilt and thus present less than the normal tyre surface. The tyre width is usually about 1¼ in., and the barrow often carries as much as 800 lb. The wheelbarrow is as much used for passenger traffic as for anything else; it will seat four people, the charge being about 2*d.* per mile. The wages of a wheelbarrow coolie vary from about 6*d.* per day in North China to 8*d.* in the Yangtse Valley.

Such ill-designed transport and abominable roads make the stagnation, ignorance and misery which exist within 30 miles of any railway or treaty port easily understandable. The civilising influence of railways in this country needs little illustration, but it may be stated as an instance, that previous to the building of the Southern Section of the Tientsin–Pukow (No. 10) Railway, there were in existence three entirely different systems of coinage in a length of about 150 miles. The units of length and capacity varied from village to village, and most men believed their market town to be the biggest city in the world. This is typical of conditions in the closed portions of the country. It should also be stated that the roads all over the country are infested by bandits.

Finally, that this, the richest part of China, has repeatedly suffered from famine, is another proof of the wretchedness of communications. Thus, in 1877–8, a famine in Honan, Shansi, Shantung and Chili is estimated to have wiped out 8,000,000 people. Also in 1910–11, famine and floods in Northern Anwei and Kiangsu were responsible for thousands of deaths. With regard to the cost of the various modes of transport, this necessarily varies somewhat in a country where labour increases in cost from north to south, wages in the Yangtse Valley being about 50 per cent. and in Canton 100 per cent. higher than North China. The following are fair averages:—

Type.	Cost per ton-mile.	Remarks.
Cart...	... 2*d.* to 4*d.* per ton-mile	Maximum load, 1.5 ton. English cart 25 cwt., cost 7½*d.* per ton-mile.
Water	... 0.1*d.* to 0.2*d.* per ton-mile	Sailing boats up to 200 tons. An extra of 4*d.* per ton for loading is charged.
Wheel-barrow	2*d.* to 6*d.*, according to state of roads	Maximum load, 800 lb.
Mule	... 3*d.* ...	... Maximum load, 200 lb. to 270 lb.
Railway	... 0.2*d.* ...	... Cost to Government.

It is of some interest to compare the cost of water and rail carriage in European countries:—

Country.	Water Carriage per ton-mile.	Rail Carriage per ton-mile.
Russia	... 0.08*d.* to 0.42*d.* (Volga)	0.49*d.*
Germany	... 0.5*d.* to 1.315*d.*	... 0.055*d.* to 0.353*d.*
Austria	... 0.87*d.* (Danube)	...
France	... 0.141*d.* ...	... 0.11*d.* to 0.78*d.*
Belgium	... —	0.08*d.* to 0.78*d.*

Considering that the price paid for labour generally is about one-tenth that paid in Europe, transport in China is expensive, uncertain and under present conditions incapable of handling any large volume of traffic except on the railways, which are too few.

(To be continued.)

TRACTION ON BAD ROADS OR LAND.*

By L. A. LEGROS, of Acton, Member.

THE problems involved in the design of vehicles for travelling, or for the haulage of goods, or agricultural implements, or produce over the land or bad roads, depend for their satisfactory solution upon conditions that vary widely. The worse the condition of the road or land to be traversed, the more essential it is that due account should be taken of the nature of the ground, its inequalities, its resistance to load and to those shearing forces to which its surface is subjected by tractive effort.

The methods adopted for overcoming the difficulties peculiar to such traction problems can be divided into two main classes: The one class is that in which the driving power is distributed over more than two driving wheels; the other class is that in which the tractor drives through chain tracks which reduce the insistent load. The two classes of tractor are, consequently, applicable to different conditions, and while the methods cannot be considered as competitive, the limitations of each can be best appreciated by direct comparison of their respective peculiarities and advantages.

Under the ideal conditions of traction on rails the driving power transmitted through a single pair of wheels may suffice to haul a train of many coaches or wagons. Under the less favourable conditions of ordinary roads, a single pair of driving wheels may serve to transmit the power necessary for hauling two or more trailers. Traction on the ordinary road by metal-tyred wheels, however, demands in the driving wheels a large diameter and great width of tread, in order that the insistent load may be reduced to reasonable intensity. How sensitive roads are to the loads that they carry may perhaps be best realised by considering a gravel road, on which ordinary devices can, in normal conditions, be used safely; the same devices may, however, cause serious damage when the load-carrying coefficient is even slightly disturbed, as, for example, by a thaw.

Among schemes for road haulage devised with the object of reducing the load per driving wheel may be mentioned the Renard road train,† consisting of six-wheeled vehicles. The central wheels of each vehicle were metal-tyred driving wheels, and the end wheels were fitted with rubber tyres and Ackermann steering.‡ The leading vehicle formed the power unit, and power was transmitted to the central axles of the other vehicles of the train by an articulated shaft. Under State subsidy the system had a fair trial in France, but it has not developed to any notable extent. The attempts at multiple-axle drive have, however, indirectly led to the development of the four-wheel drive, a system which, while less ambitious, has considerable advantages for some conditions of traction over the ordinary two-wheel drive.

PART I.

Four-wheel Drive.—The four-wheel drive may be combined with either two-wheel steering or four-wheel steering. An example of the first of these classes, schemes for which were proposed as early as 1898, was the touring car built by Spyker, of Amsterdam, in 1903, and exhibited at the Crystal Palace in 1904. The author has already referred to this on the discussion on a paper by M. Brillié read before the Institution.* Mr. Brillié's paper treated of an improved motor lorry of the second of these classes, driving and steering through all four wheels.

The four-wheel drive vehicles of to-day have much in common with the ordinary back-axle driven lorry, or truck, in type and arrangement of the engine and its accessories, such as carburettor, radiator and clutch, and also in the arrangements of gear-box, springing and brakes. Those features only will be described, therefore, in which the four-wheel driven vehicle differs from the ordinary type.

Four-wheel Steering.—In the ordinary front-steering vehicle, fitted with the Ackermann axle, the design endeavours to meet the condition that in plan the axles of both front wheels shall intersect at a point on the axis of the back wheels, as shown in Fig. 1, annexed. In the four-wheel drive car with four-wheel steering the problem assumes a more general form, and the condition

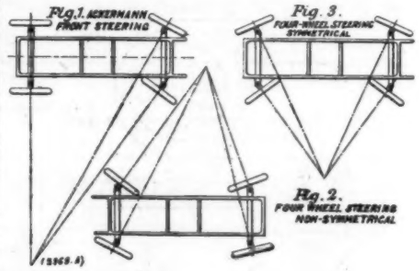


Fig.4. PATH OF WHEELS IN 180° SIDE SLIP.

to be met is that the axes of all four wheels shall intersect at the same point, Fig. 2. So long as this condition is fulfilled it is not essential that the inclination of the axes to the normal shall be the same for the front and back axles; but in practice the steering is generally symmetrical, Fig. 3, and the virtual centre about which the vehicle turns is situated on the normal centre line. This results in a reduction of the radius of the turning circle approximately to one-half of that obtained with the same front axle and with front steering only. The vehicle has therefore much greater handiness in certain respects, but is subject to the disadvantage that if brought near a kerb, and particularly a high kerb, the wheels cannot be locked sufficiently to permit of taking a small turning circle in leaving. This can be a distinct disadvantage in cities, though it is to a great extent compensated for by the greater ease with which the vehicle can be manœuvred backwards.

The locking of the rear wheels restricts the space available for framing the body of the vehicle at the height of the chassis to a narrower width than with two-wheel steering. This does not affect the arrangement of a cylindrical tank or hopper-shaped body, but for the ordinary flat platform it is necessary to give greater height than in normal practice. Although the author has not found an actual example of the non-symmetrical steering, shown in Fig. 2, it is to be noted that conversion to this arrangement involves nothing more than altering the lengths of two levers, and that the increased width of body which could be carried direct on the chassis might well compensate for the slight increase in the turning radius.

For driving over country roads or fields with many irregularities or obstacles the four-wheel drive has undoubted advantages due to the fact that the percentage of load available for adhesion is nearly double that of a two-wheel drive.

Four-wheel Braking.—The application of brakes on automobile vehicles running on ordinary or bad roads involves inevitably the possibility of side-slip. It is well known that, when the coefficient of friction for lateral displacement of the tyres is small, and the brakes are applied too hard on a vehicle with rear wheel brakes, side-slip will result, and the back of the vehicle will "come round" unless prevented by the skill of the driver. The extent of the slip can be reduced by releasing the brake and steering to the side towards which the back wheels are moving. When ordinary side-slip takes place on a cambered road, and the back of the vehicle is tending to approach the kerb, the difficulty of arresting

* Paper read before the Institution of Mechanical Engineers, on Friday, January 18, 1918.

† Proceedings Inst. of Automobile Engineers, vol. ii, pages 8, 18, 27 and vol. v, page 15; also Appendix I of present paper, Historical Note.

‡ ENGINEERING, vol. ixxxiii, pages 237 and 408 (1907), and Appendix I of present paper.

* Proceedings, I.Mech.E., 1914, page 589.

the movement is increased for two reasons; first, because the front wheels must be steered towards the kerb, thus reducing the space available for correction of the error of movement, and secondly, because the camber of the road tends to increase the lateral velocity of the vehicle. The paths taken by the wheels respectively in an ordinary rear-wheel side-slip, on a surface which is level transversely to the direction of movement, are approximately as shown in Fig. 4, in which for the sake of clearness the front wheels are shown narrower in track than the back wheels.

There is, however, another form of side-slip which is much more dreaded by the expert driver, as it is harder to check; this is front-wheel slip.* On greasy asphalt, wet oolite, and damp clayey roads, under normal running conditions the driver may be warned in time by the failure of the vehicle to respond to movement of the steering wheel. With this form of slip, application of the brake, resulting in the transference of some of the load from the back to the front wheels, may produce a sufficient change in the conditions to enable the path of the vehicle to be corrected. It is necessary to consider this aspect of the problem in motor vehicles that are rear-driven. As usually designed the axle loads are approximately equal when the vehicle is stationary; but this condition is changed when the vehicle is running, for the driving torque, corresponding to the speed of the periphery of the road wheels, acts on the back axle and relieves the front axle of part of the static load. Practical recognition of this fact is seen in the racing car, the evolution of which has shown a progressive increase in wheel base accompanied by forward displacement of the centre of gravity of the car. A racing car of 10-ft. wheel-base with a 70 brake horse-power engine, when running at 80 m.p.h., will have a torque at the back axle of about 353 ft.-lb., but the same vehicle if climbing a hill with a gear ratio of 3.5 to 1 (reducing the speed to 23 m.p.h.) will have a torque at the back axle of 1,235 ft.-lb., transferring about 1 cwt. from front to back wheel. If, on the other hand, the rear-wheel brake is applied on an ordinary vehicle, the reverse torque so set up may easily be much larger than this; and the resulting change of load conditions on the wheels may therefore increase the insistent load on the front wheels sufficiently to obtain the necessary friction between road and wheel for steering. It is obvious that front-wheel driving implies heavier loading on the front wheels, and involves greater difficulty for the driver in correcting front-wheel side-slip should it occur.

For stoppage under conditions of good road grip the four-wheel brake acting equally on all four wheels is ideal; by the use of compensating gear the braking action can be distributed equally over the four wheels, and for any given speed the car can be stopped in a much shorter distance than with two-wheel braking. When, on the other hand, the surface is greasy, a skilled driver has greater control over a vehicle braked only on the back wheels.

Four-wheel Driving.—Starley's application of the differential gear to the back axles of vehicles as a means of compensating for inequalities in diameter or in travel of the wheels requires further extension in the case of the four-wheel drive. When the vehicle is driven mechanically by a single petrol motor, it is not only necessary to provide a differential gear on each axle, but, when these are of the ordinary bevel or spur types, a third differential gear must also be interposed between the two axles to compensate for differences in the mean diameters, and consequently in the revolutions made by the respective pairs of wheels. This introduces a further complication in the problem of driving. In the ordinary two-wheel drive if one driving wheel is held and the other is off the ground, the latter will revolve, other things being equal, at double the speed at which the pair would revolve if both were free; whereas, if with the arrangement of three differentials three wheels are held and one wheel is off the ground, this wheel will revolve at four times the mean speed at which the four would revolve if free or driving normally. Conditions under which the load on any one wheel is so far reduced as to allow of slipping occur frequently on very uneven ground owing to release of spring pressure, and they also occur on ground presenting considerable fluctuations in coefficient of friction. To enable the four-wheel drive vehicle, fitted with the usual bevel or spur-wheel types of differentials, to work under these conditions it has been found necessary to fit a differential lock to the main or central differential on the longitudinal driving shaft connecting the two axle drives.

This difficulty is not so serious in vehicles fitted with electric drives, in which it is, of course, possible to fit a separate motor to each wheel. An arrangement of this kind is used in the couple-gear car, and is shown in Fig. 32, to be given later on.

Automatic Differential Locking Gears.—The problem of power transmission when one wheel is off the ground, or has no hold, as when in a clay hole or on ice, may, however, be solved in another way. The slipping or free-running of one wheel is due to the fact that the ordinary bevel or spur differential gear is perfectly reversible. If one wheel is jacked off the ground it will revolve at twice the normal speed corresponding to the engine revolutions; and *vice versa*, if the wheel is turned round by hand the engine will make half the corresponding number of revolutions. An attempt made by Hedgeland, about 1905, to solve this problem proved partially successful;* but a really practical solution appears to have been found in the worm-gear differential.

The M. and S. differential, shown in Fig. 5, is of this type.† In this arrangement each axle end carries a crown worm wheel of the same hand, each gearing into a worm pinion carried in the differential box; the two worm pinions are geared into an intermediate worm also carried in the differential box. In practice the

Fig. 5. M. & S. DIFFERENTIAL.

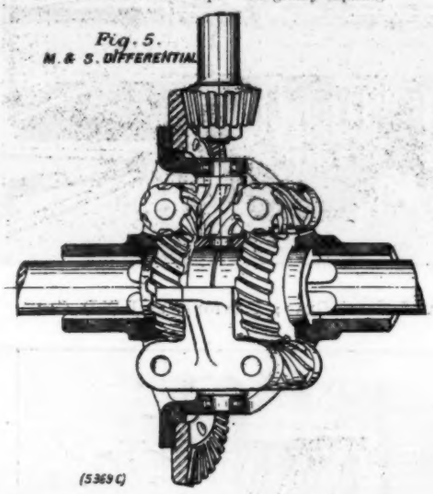


Fig. 6. MILLER AUTOMATIC LOCKING DIFFERENTIAL

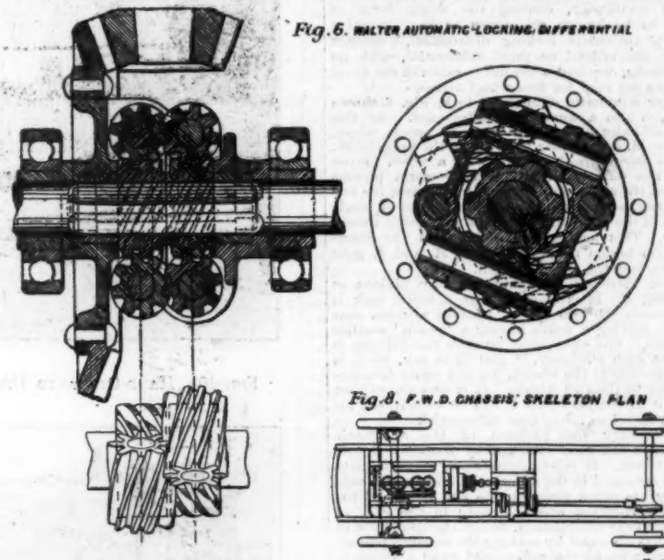
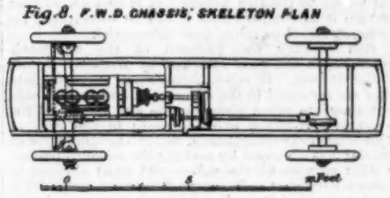


Fig. 8. F.W.D. CHASSIS; SKELETON PLAN



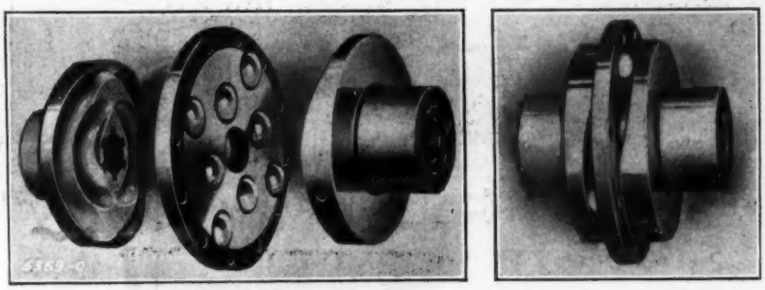
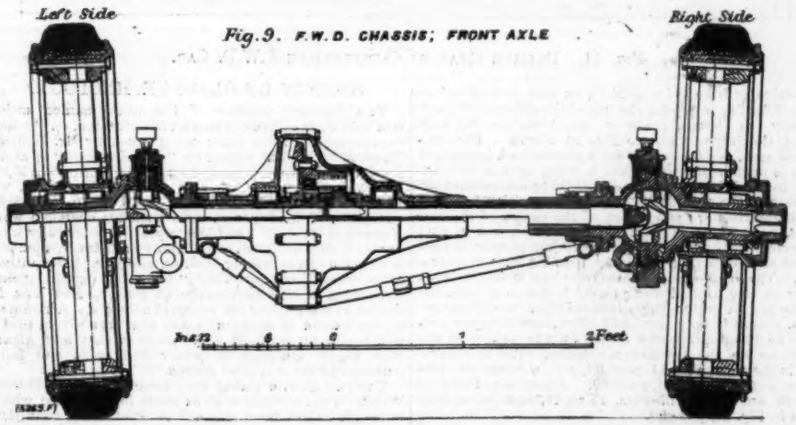


FIG. 7. THE DOBB MILLER AUTOMATIC DIFFERENTIAL LOCKING GEAR.

Fig. 9. F.W.D. CHASSIS; FRONT AXLE



* Proceedings, Inst. of Automobile Engineers, vol. ii, pages 57 to 163.

* See Historical Note in Appendix I.

† See the paper on "Differential Substitutes," by D. D. Ormsby. Transactions of the (American) Society of Automobile Engineers, vol. xi, 1916, Part II, pages 288 to 290.

arrangement of secondary and intermediate worms is duplicated as shown in the figure. The inclination of the teeth is selected so that the worm pinion can be driven by the crown worm wheel, but that the action is not reversible. Hence the gear will admit of the road wheels travelling at different speeds if both are in contact with the ground, but if one wheel is off the ground or has no hold, the irreversibility of the drive causes the whole arrangement to behave as though it were a solid axle. This peculiarity, causing the worm form of differential to be known sometimes as the "positive drive" or "automatic locking differential," renders unnecessary the central or third differential, with its differential locks, required when differentials of the bevel or spur types are used for four-wheel drives.

The Walter automatic differential lock, Fig. 6, shown in page 87, is also a worm-gear differential. In this form the half-axles each carry a crown worm wheel, and as in the M. and S. gear both are of the same hand. Each crown worm wheel engages with a worm pinion carried in the differential box; these worm pinions being both of the same hand are carried on axes, the one of which is advanced in relation to the other at an angle double that of the inclination of the worm pinion thread to its axis. This arrangement eliminates the intermediate worm pinion necessary in the M. and S. gear and thus shortens the overall length.

In practice there are two pairs of worm pinions as shown in Fig. 6. It is claimed that a static lock is ensured between the two axles "because a worm gear cannot start driving a worm having a 'much' smaller angle of lead," but that once started the driving is performed at high efficiency,"* that is to say, there is differential driving of the wheels, but not equal distribution of power to the two wheels. It is also stated that this design is so compact that it can be substituted for the ordinary bevel or mitre gear differential.

In this country the problem of the automatic differential lock has been attacked by Wolseley Motors in a different way. In one example small multiple-plate clutches are arranged in the differential box at each side so that they are acted upon by the end thrust of the gears; this end-thrust exists already in the case of bevel or mitre gear differentials, but in the spur form of differential it is obtained by making the satellite pinions (with axes parallel to the differential axis) alternately right and left-handed worms geared together and gearing respectively with left and right-handed worm wheels, of the same tooth inclination, carried on the respective ends of the axle halves; the end thrust of these worm wheels acts on the multiple-plate clutches in the same manner as in the bevel or mitre gear differentials.

The possibility that the automatic action may not ensure complete locking of the wheel or wheels is provided for in a modification of the arrangement. In this form the multiple-plate clutch sleeves carrying the thrusting wheels (whether bevel or worm) are provided with collars against which forked levers pivoted to the differential axle casing can be made to press by means of a hand lever acting through appropriate linkwork. The gear thus forms a partial lock under normal conditions and becomes a complete lock when desired.

Another form of differential locking automatically is the Dorr Miller, Fig. 7, page 87.† This gear consists of the following parts: A central driving plate, eight steel balls carried in holes in the driving plate, two groove blocks with axially-waved races for the balls, and two friction plates, one on the back of each groove block, having one face bearing on the groove block, and the other on the inside of the differential box. As soon as spinning or skidding starts, the groove block which tends to move faster also tends to move away from the central driving plates by the action of the balls in the waved grooves. This action causes the outer surfaces of the groove blocks to bind against the inside surfaces of the friction plates, which in turn tend to bind on the inside of the differential box, thereby converting the differential temporarily into a solid unit. Under normal conditions it is claimed that the rolling of the balls over the waved grooves permits perfect differential action.

It is the author's opinion that it is desirable that comparative tests of the various forms of automatic differential lock should be made by an independent authority, such as the National Physical Laboratory.

Four-wheel Drive, Front Steering.—The F.W.D. (four-wheel drive) car of Clintonville, Wis., Fig. 12, page 89, is a four-wheel driven car with front steering, and is fitted with hand-operated differential locks to the central differential, Fig. 10, annexed. A skeleton plan of the arrangement of engine and drive is given in Fig. 8, page 87, and details of the front-wheel driving and steering arrangements as seen from the front of the vehicle are shown in Fig. 9. The driving gear is shown in phantom view in Fig. 11, annexed. A dog clutch is provided for locking the central differential, and making it inoperative as a balance gear between the two axles. With the central differential locked, one or other of the clutches on the short shafts, which transmit power to the front and back wheels respectively, can be disengaged by the corresponding dog clutch; one of these clutches is shown disengaged on the right of the chain-driven differential in Fig. 11, annexed. By these means the vehicle can be converted temporarily into a two-wheel back-drive or front-drive vehicle, as may be best suited to the difficulty requiring the use of the differential lock. Actually two locking gears are provided, one for each end of the differential, see Fig. 10, above. For continuous work as a two-wheel drive car the lock is engaged which is next to the shaft that is being used in driving, so as to avoid transmitting the locking action through the teeth of the differential gear. The position in which the differentials are placed out of the centre of the car, Fig. 8, page 87, is in part constructional, and in part is selected with the object of obtaining greater central ground clearance than would be possible with a central drive. The back-axle drive of this car is of the kind known as the "full floating type,"* that is to say, the axle is one in which the wheel-driving, or differential shafts, transmit only torsional effort, and are not subjected to bending stresses either by the weight of the vehicle or by the tractive resistance. The front-axle drive is shown in Fig. 14, page 90, and a complete side-tipping wagon in Fig. 13, page 89. Examples of wagons at work are shown in Figs. 15 to 17, and an end-tip wagon in Fig. 18, page 90.

(To be continued.)

* The word "much" has been inserted by the author in the description here given, because the context implied it. The conditions for irreversibility are given by Lanchester in his paper on "Worm Gear." Proceedings, Inst. of Automobile Engineers, vol. ii, pages 219 *et seq.*

† The author is indebted to Mr. A. A. Remington, M.I.Mech.E., chief engineer of the Wolseley Company, for the description of this gear and of the two forms of Wolseley gear.

TRACTION ON BAD ROADS OR LAND.

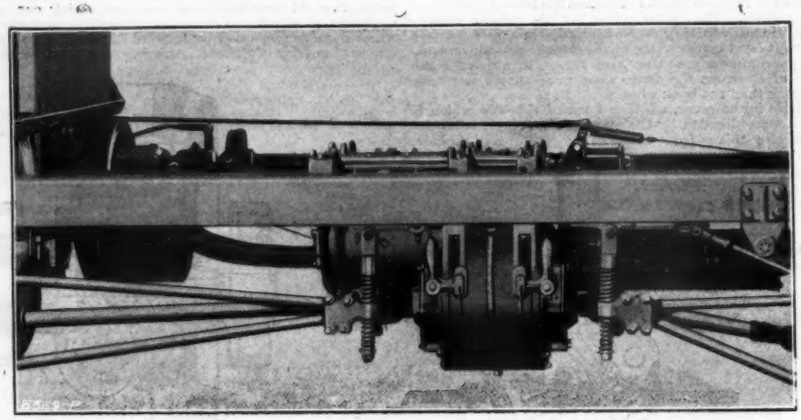


FIG. 10. HAND-OPERATED DIFFERENTIAL LOCKING GEAR; CLINTONVILLE F.W.D. CAR.

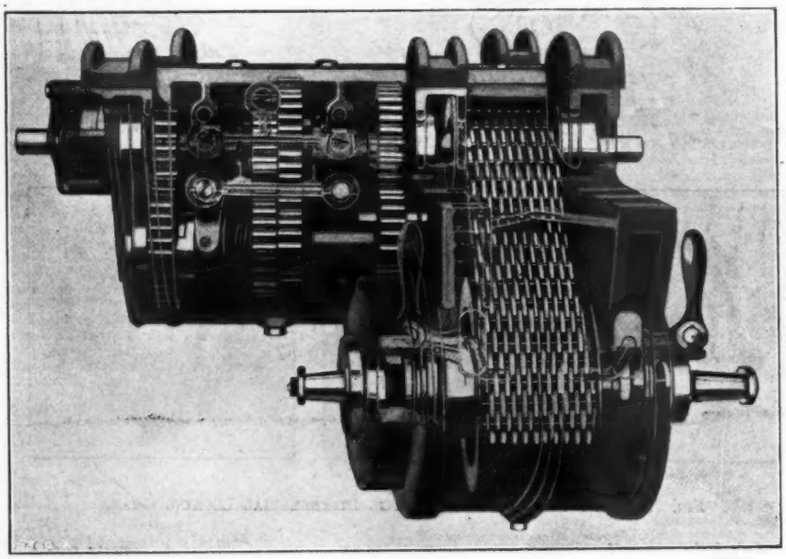


FIG. 11. DRIVING GEAR OF CLINTONVILLE F.W.D. CAR.

TRADING WITH THE ENEMY ACT.—The Controller of the Foreign Trade Department has sent us a copy of a new list (No. 45) of additions to the Statutory List of firms of enemy nationality or enemy association with whom persons in the United Kingdom are forbidden to trade. Copies of this list can be obtained at a trifling cost from the Superintendent of Publications, H.M. Stationery Office, Imperial House, Kingsway, W.C.

* "Live Axles for Commercial Vehicles," by G. W. Watson. Proceedings, Inst. of Automobile Engineers, vol. x, pages 165 *et seq.*

SOCIETY OF GLASS TECHNOLOGY.

THE January meeting of the above-named society was held in the Music Theatre, Stourbridge, on Wednesday, January 16, the chair being taken by Mr. Williams Thomas. The first paper, on "*The Durability of Heavy Lead Potash Glass*," by Messrs. J. D. Cauwood, M.Sc., W. E. S. Turner, D.Sc., and Mr. Duncan Webb, was communicated by the first-named. Prior to 1870 large quantities of lead glasses were used for chemical ware. Nowadays lead in chemical ware is practically non-existent, only one glass out of many used for this purpose gave signs of containing lead, on analysis. The authors have carried out durability tests on certain glasses containing a high percentage of lead to find how far they were resistant to the action of solvents. A summary of the results of workers in the past was given, and it was found by most of these workers that lead glasses were highly resistant to water and acids and fairly resistant to the action of alkalis.

The two glasses tested were supplied by Mr. Duncan Webb. One, a window glass made in 1845, and which, although it had been exposed to weathering conditions for more than fifty years, showed no diminution in brilliancy, had the following analysis: BlO_2, 47.1 per cent.; PbO, 41.2 per cent.; K_2O, 8.3 per cent.; Al_2O_3, 0.6 per cent.; CaO, 1.3 per cent.; B_2O_3, 1.2 per cent. The other glass was a tumbler made in the early 'fifties, and which also had lost none of its brilliancy. It had the following percentage composition: SlO_2, 54.7; PbO, 28.0; K_2O, 16.7; Al_2O_3, 0.6; CaO, trace. Five tests in all were applied, namely: (1) Boiling hydrochloric acid, (2) 2N, sodium carbonate, (3) 2N caustic soda, (4) boiling water, (5) water under pressure (autoclave). The results obtained were as follows:—

1. *Boiling Acid.*—The two lead glasses were superior to any of the modern chemical ware glasses, being far superior to Jena.

TRACTION ON BAD ROADS OR LAND.

(*For Description, see Page* 86.)

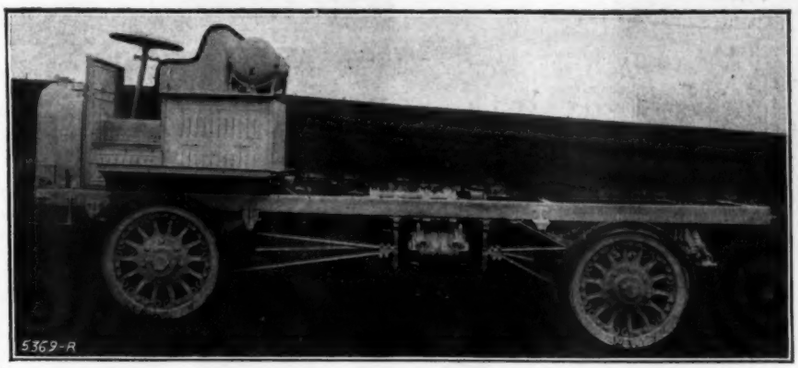


FIG. 12. THE FOUR-WHEEL DRIVE CLIFTONVILLE CAR.

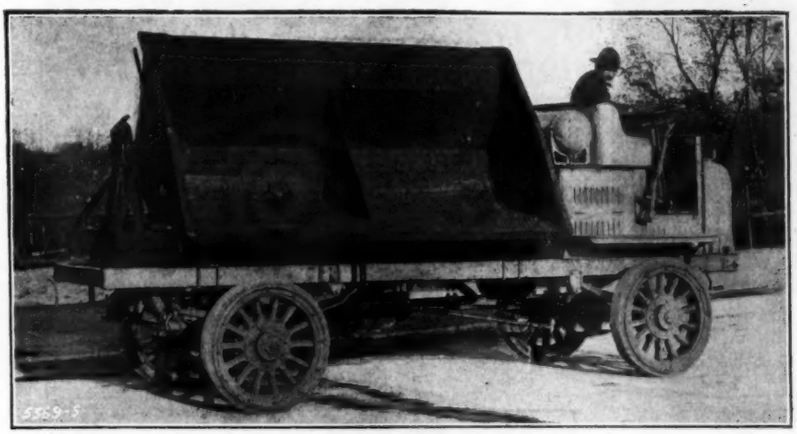


FIG. 13. FOUR-WHEEL DRIVE SIDE TIPPING WAGON.

2. *Sodium Carbonate*—The lead glasses were slightly inferior to the best modern chemical ware.

3. *Caustic Soda.*—The lead glasses showed slight inferiority.

4. *Autoclave Test.*—The window glass was superior and the tumbler inferior to modern chemical ware.

5. *Boiling Water.*—Both lead glasses were equal in behaviour to the chemical ware.

In each case actual results were quoted. It is obvious from these results that lead glasses are quite satisfactory from the point of view of both weathering and the attack of reagents.

The second paper, entitled "*Notes on the Annealing of Glass*," by S. English, M.Sc., and W. E. S. Turner, D.Sc., was read by Mr. English.

Investigations had been carried out on two particular glasses by a special method which was described, and it was found that 620 deg. C. was the temperature at which the strain rapidly disappeared from one glass, 460 deg. C. for the other. Lantern slides illustrative of the method used were shown as well as curves showing results. The effect of temperature on annealing was also investigated. Thus in the case of one glass, annealing was complete in 6½ hours at 400 deg. C., in 2½ hours at 425 deg. C., and in 12 minutes at 450 deg. C.

As the method outlined was a laboratory one involving expensive apparatus, a more simple method involving the measurement of bending of rods of glass had been worked out. It was found that the temperature at which a glass showed rapid bending without actual softening corresponds to the actual annealing temperature. The method could be applied, and in fact had been introduced into works practice. When a particular type of glass was placed in the lear a rod was made from it and also placed in the lear, resting on a brick. This rod was about 4 ft. long and 7 mm. in diameter. When the bending at the ends was only ¼ in., the annealing was again unsatisfactory, as all the ware "fled," if the rod bent until it touched the floor of the lear, the annealing was again unsatisfactory as all the ware was "melted." Satisfactory annealing was attained by a bending at the ends of about 1 in. Various types of cooling curves were discussed, and it was shown that the best cooling curve in a lear was a sinuous curve.

The third paper, on "*An Account of a New Blowpipe with Preheated Gas*," was read by W. A. Whatmough, B.Sc., A.I.C. The actual working of the instrument was shown, and its construction explained.

The fourth paper was read by S. English, M.Sc., dealing with "*A New Variable Jet Blowpipe.*" As in the previous paper, the instrument was shown in actual use.

Prior to the meeting, visits were made by parties of members to the works of: (1) Messrs. Stevens and Williams, Brierley Hill; (2) Messrs. Thomas Webb, Limited, Stourbridge; and (3) Messrs. Webb and Corbett, Limited, Stourbridge.

The thanks of the society are due to these firms for their kindness, which was highly appreciated by the visitors.

The next meeting of the society will be held at Sheffield on Wednesday, February 20, 1918.

THE SIEMENS-SCHUCKERT CONCERN.

THE reports of the three undertakings, generally known as the Siemens-Schuckert concern, contain several items of interest. Thus the Siemens-Schuckert Werke emphasise the superiority and the adaptability of electric power transmission, made manifest in all the industrial extensions and enlargements rendered necessary by the war. There has not been an object used in the war, from the largest gun to the finest wire at which electricity has not been brought into play. The manufacture of substitutes had been perfected and greatly increased, and their use in electricity had not caused any difficulties of special moment. The use of aluminium will survive the war, and will influence to a material extent the imports of copper from America. The Siemens and Halske Company also emphasise the fact, that the war has tended to bring into further relief the general importance of electricity in war as in peace. Orders at all the works far exceeded the works' capacity of output; the turnover shows a considerable increase, but the amount of unexecuted orders has grown very materially. The Schuckert and Company undertaking, in their report, draw special attention upon the large hydro-electric power projects in Bavaria, in which the company have been interested for several years, and which now are likely to be advanced. The schemes comprise those of two separate companies for the exploitation of the middle Isar and the upper Inn; and the large Walchensee project, in which the State of Bavaria in all probability will take an active part, is likely to be proceeded with before long.

The Siemens-Schuckert concerns have not done so well in the year 1916–17, as has the Allgemeine Elektricitäts Gesellschaft. Comparisons of the results of the past five years are given in the appended tables. The principal figures for the Siemens and Halske Company were:—

	Marks.
Gross profits—	
1916–17	16,700,979
1915–16	16,142,285
1914–15	17,683,726
1913–14	13,222,009
1912–13	14,663,706
Net profits—	
1916–17	12,875,261
1915–16	12,503,549
1914–15	12,538,327
1913–14	11,151,906
1912–13	12,511,197

The dividend was again fixed at 12 per cent. and, as was the case during all the years referred to above, 2,000,000 marks have been added to the special reserve and 500,000 marks to the reserve fund. The bank credit amounted to 22,300,000 marks, a decline of 5,000,000 marks; stocks and bonds had risen from 7,100,000 marks to 13,500,000 marks; different shares showed the large figure of 81,500,000 marks; raw materials represented only 4,400,000 marks, which, however, is considerably more than last year; and manufactured goods 34,600,000 marks, against 21,300,000 marks for the previous year.

The Siemens-Schuckert Werke, under which is all the high-voltage business, both of Siemens and Halske and the Schuckert Electricity Company, show the following figures in their balance sheet:—

	Marks.
Gross profits—	
1916–17	26,197,092
1915–16	25,499,871
1914–15	27,988,987
1913–14	21,274,418
1912–13	23,341,403
Net profits—	
1916–17	15,878,704
1915–16	15,310,826
1914–15	17,775,473
1913–14	11,495,103
1912–13	13,847,970

A sum of 2,500,000 marks again went to the reserve fund, 1,500,000 marks, as in the previous year, was applied to the war-aid institution. With an equal sum in the name of Siemens and Halske, the Siemensstadt War Aid Institution now has a capital of 13,000,000 marks. In the balance sheet, bonds and stocks figure for 14,800,000 marks, or 3,000,000 marks less than a year ago; various debtors show the large sum of 191,000,000 marks; raw materials stand booked at 31,100,000 marks, or about twice as much as a year ago; and manufactured goods are valued at 52,800,000 marks, against 33,700,000 marks in the former balance-sheet. On the other hand, installations in course of construction have receded from 29,100,000 marks to 18,900,000 marks. Of property and plant only the land and the buildings, as with Siemens and Halske, figure with important sums in the balance-sheet, whilst all the machinery, tools and apparatus have been written down to 1 mark for each category; the probably substantial additions under these heads made during the past year have in the main been covered in the aggregate writings-off, which have not been published. The dividend was again fixed at 10 per cent.

The Schuckert and Co. Electricity Company, Nüremberg, again declare a dividend of 8 per cent., although the gross profits have receded from 10,331,514 marks for the previous year to 9,337,017 marks for 1916–17, and the net profits from 8,068,817 marks to 7,504,216 marks. This is attributed to the absence of any special profits.

PRICES IN DENMARK.—In Denmark the increase in prices from 1916 to the end of 1917 covers all materials; for ordinary cement it amounted to 200 per cent., for ordinary bricks to 85 per cent., for firebricks to 224 per cent., for ordinary foundry goods to 170 per cent. to 200 per cent., for 4-in. nails to 315 per cent., for asphalted pipes to 240 per cent., for galvanised iron sheets, to 400 per cent., for gas and water pipes to 240 per cent., for gravel to 88 per cent., and for cartage to 70 per cent., &c.

COLLOIDAL NICKEL.—Suspensions of colloidal nickel can be prepared in various ways. From oxides and certain salts nickel is reduced into dry state by hydrogen at 200 deg. C. It occurred to C. Kelber (Berichte Deutsch Chemische Gesellschaft, October 20, 1917) to try this reduction by hydrogen in solutions. He dissolved nickel formate together with gelatine in glycerine, heated the solution to 200 or 210 deg. and passed a current of hydrogen through this solution. A brownish solution was obtained which did not turn turbid when exposed to the atmosphere and could be mixed with alcohol. Water precipitated a chestnut-brown colloid which, purified in a centrifugal apparatus and dried at ordinary temperature, gave a colloidal nickel, soluble in acidulated water, diluted acetic acid, glycerine, and alcohol. The gelatine may be replaced by gum arabic, and the reduction also be effected by hydrizine.

TRACTION ON BAD ROADS OR LAND.

(*For Description, see Page* 86.)

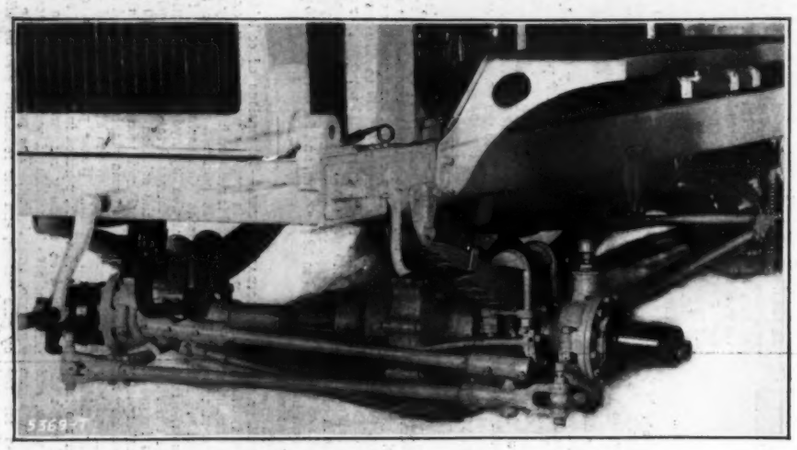


FIG. 14. FRONT WHEEL DRIVE, CLIFTONVILLE FOUR-WHEEL DRIVE CAR.

FIG. 15.

FIG. 16.

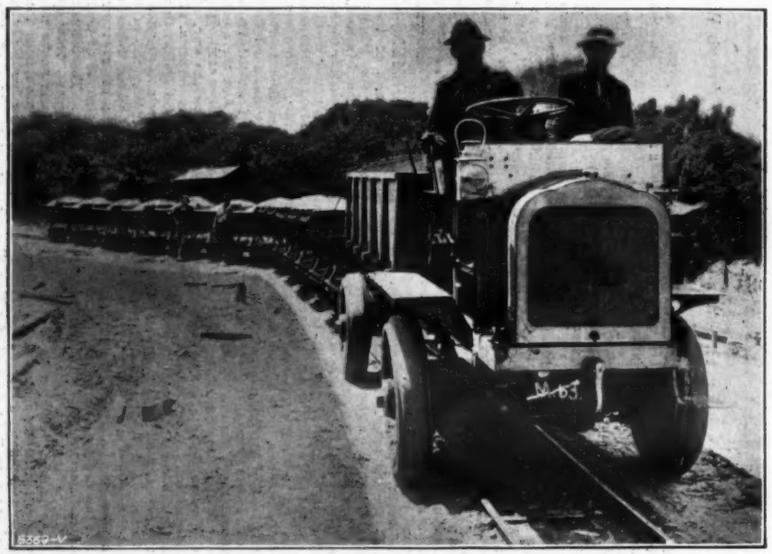


FIG. 17. CLIFTONVILLE FOUR-WHEEL DRIVE SIDE-TIPPING WAGON.

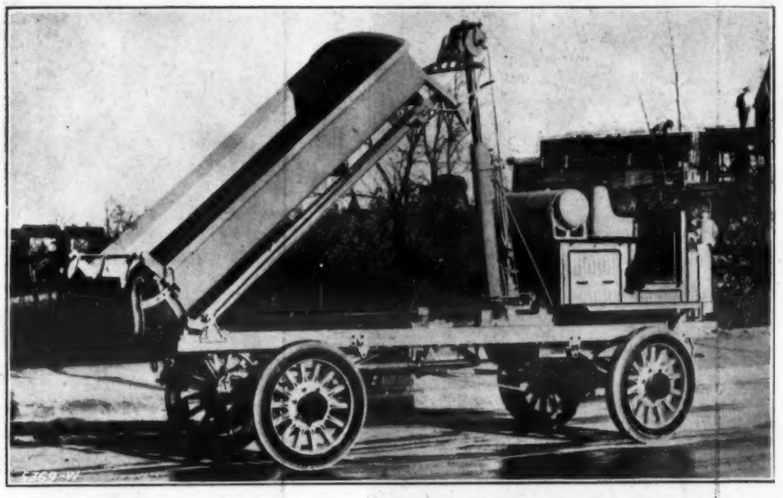
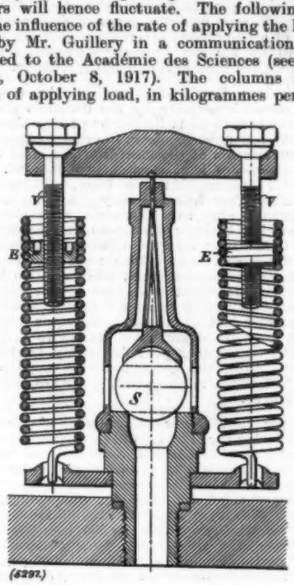


FIG. 18. CLIFTONVILLE FOUR-WHEEL DRIVE END-TIPPING WAGON.

APPLYING THE BRINELL TEST.

In the Brinell hardness test a steel ball is forced by a load or hydraulic pressure into the material under test, and the Brinell hardness number is the quotient of the load applied in kilogrammes divided by the spherical surface of the impression produced by the ball. To arrive at numerical values, either the depth of the impression, or the diameter of the impression is measured; the latter measurement is more convenient. In laboratory practice a steel ball of 10 mm. diameter is usually loaded with 3,000 kg., and the measurement is taken after 5 minutes; the practice varies, however. The test has been found very valuable in munition works; but 5 minutes cannot be spared for a test which has to be repeated thousands of times in the course of a day. In French munition works 10 seconds are said to be allowed, and it is admitted that the measurements may then be incorrect by 8 per cent. The quicker the rate of putting on the load, the smaller will the observed impression be, since a hard material will continue to yield gradually. With varying rates of putting on the load, the Brinell numbers will hence fluctuate. The following figures as to the influence of the rate of applying the load were given by Mr. Guillery in a communication recently presented to the Académie des Sciences (see *Comptes Rendus*, October 8, 1917). The columns indicate: A, rate of applying load, in kilogrammes per second;



(5297.)

D, diameter of impression in millimetres; B H, Brinell hardness number; T.S., tensile strength in kilogrammes per square millimetre; the intermediate columns indicate the errors, and the last column gives the percentage error; I refers to a soft steel, II to a semi-hard steel:—

	A.	D.		B. H		T. S.		Per cent.
I	0	4.74	0	159	0	55.6	0	0
	12.5	4.72	0.02	161	2	56.3	0.7	1.2
	25	4.70	0.04	163	4	57.0	1.4	2.4
	1500	4.60	0.14	171	8	59.8	4.2	7.1
II	0	4.094	0	212.5	0	74.3	0	0
	12.5	4.074	0.020	217	4.5	76.0	1.7	2.2
	25.	4.059	0.35	221.5	9	77.7	3.3	4.3
	1500	3.975	0.118	227.	14.5	79.4	5.4	7.

Mr. Guillery obviates these errors by means of a simple mechanical contrivance which is based upon the following considerations. If the pressure were released immediately after reaching the maximum value of 3,000 kg., the diameter measured would be too small by the differential quantity d D; if, on the other hand, the load were increased to (3,000 + d P), the diameter would be too great. For the increment d P the error resulting from the insufficient duration of the pressure-effect can be compensated for in accordance with the relation: d P/3,000 = 2 d D/D. In the case when the load was applied at the rate of 1,500 kg. per second (fourth row of I), d D was 0.14, and hence: d P = 3,000 × 2 × 0.14/4.74 = 177 kg.

To effect this compensation, that is to say, to regulate the maximum pressure automatically in accordance with the rate of charge, so as to be able to obtain correct results at a rapid rate, Mr. Guillery devised the apparatus illustrated in the annexed diagram. The pressure is applied by the aid of a hydraulic piston, the action of which is limited by the ball valve S. The lift of S is opposed by the spiral springs, which can be adjusted in two ways, firstly by the aid of the screws V, and secondly by the aid of the nuts E which on their outer circumferences, are threaded to fit the convolutions of the spiral spring. The tension is altered by adjusting the screw V, and the position of E, which he turned up and down, adjusts the height of the spiral spring which is being utilised. By trial now the operator determines the impressions which, in the case of a certain steel, are normal for two rates of putting on the load, the rates varying in the ratio of 1 to 30; the device will then be adjusted also for any rate of applying the load intermediate between the limits adopted. Thus it will not matter whether the load is put on a little more or less rapidly than in the usual practice. The following figures show the accuracy which has been realised with the aid of this device; the upper row indicates the rate of applying the load, in kilogrammes per second, the lower row the corresponding diameter of the impression produced, in millimetres:—

100	200	300	600	1,000	1,500	3,000 kg.
4.38	4.37	4.40	4.39	4.40	4.39	4.39 mm.

The agreement looks satisfactory. Strictly speaking, a new adjustment should be made for every style of metal. It has been found, however, that the same adjustment will suffice for carbon steels and special steels which have undergone some thermal treatment. Guillery gives the following diameter values in support of this statement; the first line indicates the rate of application of the load in kilogrammes per second, the last column referring to the standard Brinell test:—

	12.5	100	600	3,000	Standard.
Soft steel	5.67	5 66	5,67	5,68	5.66
Semi-hard steel ..	4.40	4.36	4.36	4.36	4.36
Nickel-chrome steel ..	3.63	3.60	3.59	3.62	3.38
Same, reheated ..	2.61	2.62	2.62	2.63	2.60

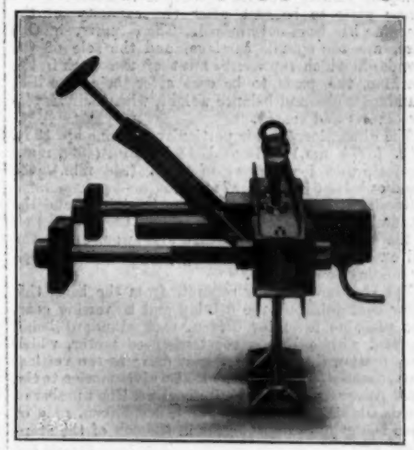
Mr. Guillery states that the device has been working for several months without having failed on any occasion. With specimens of similar form, easy to handle, 600 tests can be performed per hour, 8 seconds of the 10 seconds of a test being required for the manipulations and 2 seconds for putting on the pressure. After a time, we should think, the spiral springs will need correction and renewal, and the question may be asked, whether the spring device, unless in itself a convenience, really offers sufficient advantage, considering that the engineer frequently has to reckon with experimental errors of a few per cent.

THE NEW SWEDISH DYE INDUSTRY.—In no industry, probably, has the war caused more new departures than in that of dye stuffs, and no new ventures are watched with keener interest and jealousy in Germany than these inroads upon what used to be considered almost a German monopoly. In Sweden the projected Swedish Dye Stuffs Industry Company has now been formed, under very favourable auspices, with a distinguished board, and a capital of £660,000. The new concern has acquired several undertakings, which have been carrying on kindred industries. These comprise the Chemical Industries Company, the chemical factories of the Apothecaries and the Wich-Becker Company. The company has also purchased all the property of the Swedish Jute Weaving Company, at Södertelje.

A HUGE COMBINE IN THE GERMAN IRON INDUSTRY.—A huge combine or arrangement within the German industry, probably the most comprehensive hitherto recorded, is the taking over, through more or less compulsory liquidation, of the de Wendel undertakings, and their passing into German ownership. The price amounts to about 350,000,000 marks, and the largest concerns in the German industry are interested in the venture; it is further understood that an optional portion is being reserved for the German Empire. The syndicate which takes over the de Wendel undertakings comprises Fried-Krupp, August Thyssen, the Gelsenkirchen concern, the Roechling concern, the Gute Hoffnungs Hütte, the Phoenix Company, and other members of the German Steel Union. It also includes concerns not belonging to the so-called "mixed group," and works which go in for the manufacture of high quality steel will have interests in the combine. The allotment of portions will to a great extent be arranged according to the iron and steel production of the different works. Amongst the special works admitted into the new concern is also that of Felten and Guilleaume, Mülheim, whose reason for joining is a desire to ensure a more ample supply of iron ore for the Collart blast furnaces and steel works in Steinfurt, the whole of the share capital of which is held by the Felten and Guilleaume company. The allotment of the de Wendel Company apportioned to Felten and Guilleaume is 3 per cent., and the same share has been given to the Mannesmann tube works in Dusseldorf. The share capital, according to the present arrangement, will be 100,000,000 marks, the rest of the necessary purchase-money being found through the medium of loans and long-term credits. The German Empire is understood to be taking over 50 per cent. of the entire share capital, another important move towards getting its hand into industry. The domicile of the de Wendel iron ore mining and iron works is Hayingen.

WHEEL FORCING PRESS.

THE accompanying illustration shows a wheel forcing press which has specially been got out by Messrs. Hollings and Guest, Limited, of Thimble Mill-lane, Birmingham, for taking off the wheels of Foden and other similar wagons, so that they can be tyred. The wheel has to be taken off the axle before a new tyre can be put on, and up to the present there has been nothing on the market for this work. The press is very light and can be worked from the pumps of the makers' standard tyre press connected with a flexible tube so that the press can be put up against the wagons.



The cylinder is of steel, and is so made that when the pressure is on a blow can be given on the end of the cylinder to start the wheel moving; this is very often a necessary thing to do.

As will be seen from the engraving, close adjustment is given on the rods; adjustment of height is also given so that if necessary the little press could be placed on a trolley and pushed right up to the wheel. It could be put on a small trolley with a small pump so as to make it quite independent.

The small hand wheel shown on the top at an angle is an arrangement for pushing back the ram. The appliance is strongly built, and as there is no cast-iron in it, it is safe against accidental breakage.

THE NORWEGIAN MERCHANT NAVY.—Up till December 15 the war losses of the Norwegian merchant navy amounted to 532 steamers and 162 sailing vessels, altogether 694 vessels with an aggregate tonnage of 1,022,771 registered tons; 835 men, women and children have perished and 12 persons are missing.

GRAPHITE FLOTATION.—As we have several times referred to the successful concentration of minerals by flotation processes, we may mention that flotation has recently been applied by the Kattowitz Graphitwerke, in Silesia, for working up inferior graphite. In order to stir the aqueous, oily pulp, air is pressed into it by the aid of wheels with horizontal axes, the radial paddles of which move through the pulp. Big bubbles are thus introduced, whilst other inventors prefer small bubbles for floating, it is claimed that very little oil need be added to the pulp. The floated graphite afterwards passes into settling tanks.

BASALT LAVA FOR FILTER BEDS.—The basaltic lava of the Eifel districts of Rhenish Prussia has for some time been utilised as material for the filter beds of sewage plant. According to Doctors Hambloch and Marziol, it is also an excellent material for the filter beds of the water supply. The lava requires a certain preparation for this latter purpose. The lava is ground down to different sizes and treated with diluted hydrochloric acid or with soda lye; after drying the material is baked. The treatment is said to remove objectionable constituents and to render the grains more porous. The lava is much cheaper than the kreselguhr which it replaces.

MANGANESE.—Manganese is one of the minerals with which nature has been niggardly in her supply to America, says *Engineering and Mining Journal*, New York, and it has hitherto been imported, either as ore or ferro-manganese. America's need arises from the fact that 17 lb. of manganese, or roughly 0.75 per cent., is required per gross ton of steel to deoxidise the steel and make it a useful product. There have been in the past three principal sources of supply of manganese: the Caucasus Mountains, India and Brazil. But Brazil is a bad third, producing roughly only about 250,000 tons, as against nearly 1,000,000 tons for the Caucasus. The Russian deposits were cut off from America entirely by the closing of the Dardanelles. The Indian fields are at so great a distance that the freight under present conditions has become absolutely prohibitive. Of the three principal fields, therefore, only the Brazilian remains available for the United States.

5-INCH SPINDLE DUPLEX BORING, DRILLING AND MILLING MACHINE.

WE illustrate on page 94 a duplex horizontal boring, drilling and milling machine, which has been constructed at the works of Messrs. G. and A. Harvey, Limited, of Govan, Glasgow, for a well-known Clyde-side shipbuilding and engineering firm. The capacity of this particular machine is greater than is usual in this duplex size, but it serves to illustrate how these machines can be altered to suit firms' individual requirements. Certain parts are carried in stock, these parts being the smaller and more complicated, leaving the larger parts to be cast after the capacity of the machine has been determined. These parts, in this case, are the spindle carriage, and the sole of the standard, which represents most of the work in the machine, the parts to be cast after being the bed, standard tables and balance weight, with their respective shafts and screws.

The dimensions of this particular machine are 18 ft. 9 in. (5714 mm.) horizontal, 13 ft. 3 in. (4038 mm.) vertical, with feed travel of 3 ft. (914 mm.), the spindles being 5 in. dia. (127 mm.).

Special attention has been given to rigidity and the standard has its base well spread out, the box section of the body being nicely tapered and swept out to the full extent of the base, leaving just sufficient flange for holding down screws.

The standard body is separate from the base, this latter containing all the driving and traversing gear. The machine is motor driven, each standard being supplied with a 15-h.p. constant-speed motor, which gives motion through an all-gear drive to the vertical shaft, thence to the spindle. It also gives motion to the rapid power traverse and milling gears. The number of speeds obtainable for the spindle is eighteen, nine of these being by change of gear in the sole of the standards, and two in the saddles. The nine speeds are obtained by means of ten wheels, which are arranged to slide on shafts by two levers on the outside of the sole. Perfect reliability is assured by this arrangement, as no interlocking can take place and there is ample strength for the power the wheels have to transmit. The maximum speed of the spindle is 148 r.p.m., and the minimum speed 3·3 r.p.m., with a good range between. The power traverse speed is constant, and a varying milling feed is obtained by the use of change wheels. The clutch which disconnects the rapid power traverse is thrown to the other side and a reverse face gears with the worm wheel, thus bringing into gear the milling traverse, so that there is no difficulty about starting a new cut on a milled surface, as the standard can be quickly brought back without disturbing the gears. The hand adjustment is as easily operated and being very powerful, a very fine adjustment can be obtained.

The spindle is carried in a balanced carriage to which is attached a strong platform for the operator to stand on, and from which he can control the machine, but not change the speeds at the sole. He has, however, always two speeds available at the saddle, which enables him to reduce the speed from a quick drilling speed to a slower tapping speed, the ratio between them being 3 to 1. This change of spindle and reversing of direction of rotation, is performed by means of two levers at the front of the saddle, and handy to the operator.

An important feature of this machine is the distribution of the different levers and hand wheels on the saddle for operating the machine. The hand wheel for starting, stopping and reversing the power or milling traverses is at the front, so that the operator has a clear view of the drill point, and can consequently bring the spindle very close to the centre of the hole to be drilled by means of the power traverse, leaving a very small margin for hand adjustment, either horizontally or vertically.

Another point worth mentioning as to the saddle is the arrangement of the hand motion for the feed gear. Four feeds are obtainable by sliding spring feather, but five wheels are to be seen on the shaft (see Fig. 1) of the saddle, and when the key is slipped into the fifth wheel, all the others are loose, and though they revolve they run loose, but the extreme right hand or fifth wheel is keyed to the shaft and a powerful hand feed can thus be used for entering a drill or facing up a boss. By this arrangement the hand wheel for the hand feed does not revolve when power feed is in use, and in addition it is absolutely impossible to cause a breakage to occur by leaving the hand feed in gear, and putting power in at the same time. The action of sliding the spring feather along puts one in and the other out automatically. There are eight feeds always available, four by the sliding key, and other four by double gear. The feeds are varied thus: 8, 16, 24, and 32 per inch without double gear, and with double gear five times finer, viz., 40, 80, 120, and 160 per inch. Stated in millimetres: 3·1, 1·59, 1·0, 0·77, 0·63, 0·31, 0·2, and 0·15 mm. per revolution.

The bed and table of the machine is of ample strength. The bed has very broad wearing surfaces, and the inside edges of the slides are used to give a long narrow guide for the standard when being moved. The tee slots in the table are planed from the solid, and there are screwed holes in the top for setting pins to facilitate levelling up before grouting.

The driving wheels are of cast or forged steel and the worm feed wheels of hard gunmetal. The teeth are machine cut from solid blanks, and worm wheel teeth are hobbed. These duplex machines are made in other two sizes, viz.: 4 in. and 6 in. spindles (101 mm. and 152 mm.).

YEAR-BOOKS AND ANNUALS.

Almanacks and Calendars.—A monthly calendar has reached us from Messrs. Yeaman and Baggesen, marine and general engineers, Dundee; also very clear, monthly tear-off calendars from Messrs. Jones and Shipman, Limited, machine tool builders, Leicester; and from Messrs. R. Y. Pickering and Co., Limited, builders of railway rolling-stock, Wishaw. Messrs. Pirelli, Limited, 144, Queen Victoria-street, E.C., have sent us a very effective daily tear-off calendar, illustrating their tyres. We have received from Messrs. Sir W. G. Armstrong, Whitworth and Co., Limited, Openshaw, Manchester, a monthly tear-off almanack showing their manufacture of crucible high-speed steel. We have further received very neat monthly tear-off calendars from Messrs. John Rogerson and Co., Limited, Wolsingham, S.O. (Durham); from Messrs. Hulse and Co., Ordsal Works, Manchester; and from Messrs. Brett's Patent Lifter Company, Limited, Coventry. A handsome desk almanack has reached us from Messrs. Stewarts and Lloyds, Limited, Tube Works, Winchester House, Old Broad Street, E.C.2. At the time of going to press, a monthly tear-off calendar reaches us from the Brown Hoisting Machinery Company, Cleveland, Ohio, U.S.A.

Diaries.—We have also received from Messrs. Sir W. G. Armstrong, Whitworth and Co., Limited, Openshaw, Manchester, a handsome leather pocket case containing a diary.

PERSONAL.—The address of the Sheffield branch of the India Rubber, Gutta Percha and Telegraph Works Company, Ltd., of Silvertown, is now 88–90, Queen-street, Sheffield, instead of 28, Angel-street.—Mr. H. C. B. Underdown has been elected a member of the Council of the British Engineers' Association as a representative of the Association of British Motor and Allied Manufacturers. Mr. Underdown, who is chairman and managing director of Commercial Cars, Ltd., of Luton, is chairman of the Commercial Vehicle Section of the A.B.M.A.M.—After 25 years' service with the Worthington Pump Company, latterly as their Resident Director at the Newark-on-Trent Works, Mr. F. B. Jack has resigned, to take up an important post at the Sheaf Works of Messrs. Ruston, Proctor and Co., Lincoln.

MANUFACTURE OF SILICA BRICKS.—In the *Comptes Rendus* of December 17, 1917, M. Philipson gives a preliminary account of researches, conducted at the Usine des Dunes in 1916 and 1917, with silica bricks of different grain size, compositions, &c. The quartz was taken from different sources; it was mixed with milk of lime for 10 minutes, the bricks were made by hand out of 200 kg. of material, they were dried at 100 deg. C. and baked at 1,300 deg. and tested. The conclusions arrived at are: (1) the strength (resistance to crushing) increased with the fineness of the grain: an impalpable powder, mixed with 2 per cent. of lime, had a strength of 18 kg. per square centimetre dry, and a strength of 320 kg. after baking; with sifted grains of 0.13 mm. the strength was only 2 kg. and 16 kg.; (2) all the kinds of quartz tried gave good bricks when well ground; (3) the swelling or dilatation consequent upon baking was greater for coarser grains than for fine grains, bricks made of impalpable powder practically did not swell; (4) the strength (dry and after baking) increased when more water was used in the preparation; (5) other things being equal, the strength also increased with the percentage of lime; thus bricks containing 0 per cent., 1 per cent., 2 per cent., 2.5 per cent. of lime had a strength of 110 kg., 280 kg., 300 kg., 250 kg.; (6) the melting-point was lowered by 20 deg. by the addition of 1 per cent. of lime. Other tests were made with bricks, all containing 2 per cent. of lime, of different grain-size, to ascertain at what temperature hardening (as evidenced by strength tests) became noticeable; when the material was an impalpable powder, a strength of 190 kg. (per square centimetre) was already reached at 800 deg., and at 1,300 deg. the strength had risen to 270 kg.; the grains of 0.13 mm. did not begin to harden before 1,100 deg., and at 1,300 deg. the strength amounted to 70 kg. Finally, bricks embodying material of several grain sizes were made; the bricks containing a minimum of impalpable powder proved the least fusible; 8 mm. seemed to be the maximum advisable grain size. In their ordinary manufacture the works use a mixture of 30 per cent. of impalpable powder and 70 per cent. of coarse grains (from 1 mm. to 8 mm.), mix the silica with 0.6 per cent. of lime and bake at 1,300 deg. in a tunnel furnace. The resulting bricks, which are now substituted for clay bricks, have an absolute density of 2.4, an apparent density of 1.9; they swell by 1.6 per cent., and their strength ranges from 200 kg. up to 250 kg. per square centimetre; they had stood more than 200 heats in Martin furnaces and were expected to bear 300 heats.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Scotch Steel Trade.—Work in the steel-making industry has made so very good a start since the holidays, with orders perhaps more plentiful than ever before in the history of the trade, that there is every prospect of new records regarding output, &c., being made. It is confidently expected that the recent improvements and extensions will make for a greatly increased output, provided, of course, that a sufficient supply of raw material is forthcoming. In the meantime there is a decided shortage, particularly of American blooms and billets which are practically unprocurable now, so that the strain upon the local producer is steadily increasing. Ordinary mercantile business is quite out of the count, and so also is export, with the solitary exception of some shipments to the Allied countries. No change has yet been made in prices, despite the talk connected with the higher cost of coal and all other fuel.

Malleable Iron Trade.—The malleable iron trade continues its prosperous and active career—orders are much in excess of normal times, and all the plant is fully employed. Naturally, the bulk of the output is absorbed by the Government contracts which are still the chief and most important work on hand, and although an idea which was recently mooted suggested the probability of setting aside a certain proportion of the available output for the ordinary mercantile trade, nothing further has come of it and talk it remains.

Scotch Pig-Iron Trade.—So long as the ceaseless activity rendered imperative by the demands for war material continues, there is little fear of any slackness in the pig-iron industry. Indeed, in order to keep pace with the requirements of the local iron and steel works the iron smelters are kept constantly employed, with every available furnace in full blast. By working during the New Year holidays they got quite a good start, being thus able to accumulate a considerable amount of stock. Perhaps the demand for hematite is greatest, as it has been for some time now, while there is still a certain shortage of both forge and foundry sorts. With Government control, however, this is not so keenly felt as it might have been under different circumstances, for every effort is made to supply the most urgent claims first and all others according as required. The makers, too, are doing their utmost to despatch all orders with the greatest possible celerity, having due regard to the difficulties connected with wagons and transport. Except where controlled, prices are stiff and likely to remain so.

The 12½ per cent. Bonus.—The Order of the War Cabinet prohibiting the carrying out of the recent agreement between local engineers and their employers, whereby it was proposed to grant to pieceworkers an additional payment of 6s. 9d. per week as an equivalent of the 12½ per cent. bonus awarded to timeworkers, has been received with very little favour in the Glasgow district, and a meeting of protest has just been held by the Clyde District Committee of the Federation of Engineering and Shipbuilding Trades. Owing to the absence of the representatives of the Amalgamated Society of Engineers it was impossible to arrive at any definite finding regarding the propriety of holding out for an extension of the scheme to all pieceworkers, but the meeting came to the conclusion that a vote of its members should be taken immediately by the unions represented as to the desirability or otherwise of a general return to timework. This scheme has the entire approval of the local district committees of the Amalgamated Society of Engineers. Should the vote be favourable to this policy, and should the change ultimately be given effect to the men, as timeworkers, will be in a position to demand the 12½ per cent. bonus. This change, however, might have rather serious results upon production. Those present at the meeting seemed confident that in the very near future the concession would be made to all pieceworkers without any drastic measures being resorted to. It is a big problem, and one involving points of much interest.

Sir Auckland Geddes to Visit the Clyde.—Although a definite date has not yet been fixed, Sir Auckland Geddes has intimated his willingness to visit the West of Scotland for the purpose of conferring with groups of trades unions on the Government's new Man-Power Bill, a movement with which the Clyde workmen are in little sympathy. Considering the present critical condition of affairs, a general cessation of labour would be disastrous in the extreme, so that some effort must be made towards a better understanding, and it is with this end in view that the prospective visit of Sir Auckland Geddes is being arranged.

SAMUEL FOX AND CO., LIMITED.—We have received from Messrs. Samuel Fox and Co., Limited, Stocksbridge Works, near Sheffield, a booklet which they have just published, describing their works and illustrating generally their products. The booklet forms a pocket-case, and contains a large number of squared paper leaves for the use of engineers and metallurgists.

IRON AND STEEL PRICES AND EXTRAS.—The Minister of Munitions has issued a notice altering the maximum prices of marked bars and limiting, as from the 22nd inst., extras chargeable on sales of steel in shell discard quality. Applications in regard to this notice should be sent to the Controller of Iron and Steel Production, Room 382, Ministry of Munitions of War, Whitehall-place, S.W. 1.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

Technical Libraries.—At a meeting held in Sheffield of the North Central Library Association an important resolution was passed urging the establishment of technical libraries as special departments of public libraries in all manufacturing towns. Dr. Ripper, Vice-Chancellor of Sheffield University, in proposing a resolution that technical libraries are as essential both to technical education and to manufacture as the laboratory or the workshop, urged that in future the libraries of the country would need to be more closely associated with the national life and industries than ever before. They would have to become a much greater source of assistance to the workers than had been the case in the past. Taking the basis of 50,000 workmen in Sheffield, if only one per thousand desired to engage in research, there should be every facility for those 50 to obtain all the book information they required.

Iron and Steel.—Business in the iron and steel trades has been to some extent hampered by the wintry weather, heavy falls of snow rendering transport of fuel and material difficult, and in some cases impossible, for days together. All round, however, the output has reached the normal level before the stoppage, and as extensions are steadily brought into operation, it will soon pass all previous records. The iron market is firm, supplies of forge and foundry irons being short. High prices are being paid for steel melting scrap and old wrought iron, both of which are very scarce. There is a fair supply of acid billets, though by no means up to the requirements of the trade. Maximum prices are suggested of 14*l.* 10*s.* for Bessemer, 15*l.* 10*s.* for Siemens-Martin and 20*l.* for file steel, these rates being net at the works. No official notification has yet, however, been received of these figures, which are somewhat lower than recently quoted. Heavy indents have been received for cross-cut saws from 6 ft. 6 in. to 7 ft. long, mainly for use in cutting timber in this country. A recent Admiralty tender is for 500 of these saws. The export trade continues to dwindle, chiefly owing to the increasing requirements of the home market. A fair amount of steel, however, is still going to Canada, Italy, China and Japan, while from Trinidad come considerable inquiries for files, and from South America for sheep shears.

South Yorkshire Coal Trade.—The past week has been quiet, the general position remaining unchanged. Supplies are not yet coming in in their normal quantities, and works have been compelled to draw on reserves. Considerable pressure is consequently being put on collieries to increase deliveries. The demand for best steam hards is more than equal to the supply. The railways are making heavy demands, and also other home consumers, while a steady export trade is maintained with Italy and France. Cobbles, nuts and slacks are of marked strength, and when contract demands are satisfied there is very little left for the open market. All classes of household fuels are in brisk request. The heavy demand for the London area is making it difficult to supply the country districts, who are suffering from scarcity. Cokes occupy a strong position, and prices all round are firm at the maximum. Pit quotations are as follows:—Best branch handpicked, 23*s.* to 24*s.*; Barnsley best Silkstone, 23*s.* to 23*s.* 6*d.*; Derbyshire best brights, 21*s.* to 22*s.*; Derbyshire house coal, 18*s.* 6*d.* to 19*s.* 6*d.*; best large nuts, 18*s.* 6*d.* to 19*s.* 6*d.*; small nuts, 17*s.* 6*d.* to 18*s.* 6*d.*; Yorkshire hards, 18*s.* 6*d.* to 19*s.* 6*d.*; Derbyshire hards, 17*s.* 9*d.* to 18*s.* 9*d.*; best slacks, 14*s.* to 14*s.* 6*d.*; seconds, 13*s.* to 13*s.* 6*d.*; smalls, 9*s.* to 10*s.* per ton at the pit.

THE INSTITUTION OF NAVAL ARCHITECTS.—It is announced that the annual meetings of the Institution of Naval Architects will take place on Wednesday, March 20, and the following day, in the Hall of the Royal Society of Arts, John-street, Adelphi, W.C. (by kind permission of their Council). The Right Hon. the Earl of Durham, K.G., G.C.V.O., P.C., President, will occupy the chair. A gold medal will be awarded by the council to any person not being a member or associate member of council, who shall at the forthcoming meetings read a paper which, in the judgment of the council, is deemed to be of exceptional merit. The council will also offer a premium of books or instruments to the reader of any paper, not being a member or associate member of council, which paper, in the judgment of the council, merits this distinction.

GYPSUM DEPOSIT IN A WATER-TUBE BOILER.—With respect to the discussion on the setting of plaster and the importance of the hydrates of $CaSO_4$ in this problem, it may be of interest to mention a recent case of a deposit of practically pure gypsum, *i.e.*, $CaSO_4.2H_2O$, in a boiler. The case is reported by Professor Goldberg in the *Chemiker Zeitung* of December 15 last. The boiler water had been run off, but a little water had been left, and had been concentrated to a mud and crystalline deposit in the course of half a year that the boiler was not used. Over this crystalline deposit were found close, well-defined crystals of gypsum, colourless or slightly yellow, in the first case containing only 0.06 per cent. of iron oxide and alumina; the crystalline deposit underneath also consisted largely of calcium sulphate, but together with magnesia, iron oxide, silica, &c. The occurrence of the hemihydrate $2CaSO_4.H_2O$ in a boiler, instead of the usually-observed anhydrous salt, had been reported by J. W. Johnston in 1838. In boilers at pressures of several atmospheres the calcium sulphate is deposited as anhydrous salt; the gypsum crystals seem only to be formed at ordinary temperature.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Trade.—Little new is ascertainable concerning the Cleveland pig iron trade. The market is quiet but steady and firm, and so far as home trade is concerned renewal of activity is confidently anticipated with the commencement of the issue of the February allocations. Good inquiries on foreign account are reported, but this month's shipments are stated to be on only a moderate scale. Only very limited cargo space can be allotted to meet the urgent needs of France and Italy, to which countries alone pig iron shipments are restricted. Shortage of labour and trucks is hampering deliveries, and if these difficulties could be overcome, there would doubtless be a marked expansion in the volume of business both on home and foreign account. Home deliveries this month are very considerably in arrears, and substantial portions of January contracts will have to be cancelled. For home consumption, No. 3 Cleveland pig iron, No. 4 foundry, and No. 4 forge all stand at 95*s.*; and No. 1 is 99*s.*; whilst for shipment to France and Italy, No. 3 and the lower qualities are all quoted 114*s.*, and No. 1 119*s.*

Hematite Iron.—The East Coast hematite position shows very little alteration, and the further restriction of output of West Coast brands is bound to react in some measure upon the already stringent situation here. At the same time further considerable increase of production of other steel-making iron manufactured from native ores is promised at an early date, and this should improve matters. Continued careful distribution, under strict official supervision, maintains deliveries on a scale sufficient to meet adequately and regularly the urgent needs of home customers, but when these have been arranged for, little surplus iron remains available for distribution among customers abroad. Nos. 1, 2 and 3 East Coast brands are 122*s.* 6*d.* for home use and 147*s.* 6*d.* for export to France and Italy.

Foreign Ore.—Transactions in foreign ore are limited to odd cargoes, consumers showing no inclination to make contracts ahead. There appears to be some expectations of a revision of prices at an early date.

Manufactured Iron and Steel.—Practically the whole of the output of manufactured iron and steel is still absorbed by the needs of the Government and of the shipyards, so that very little facility is afforded for the transaction of business in other directions. Prices are very stiff. To home customers the following are among the principal market quotations:—Common iron bars, 13*l.* 15*s.*; best bars, 14*l.* 2*s.* 6*d.*; best best bars, 14*l.* 10*s.*; iron ship plates, 15*l.* 10*s.*; iron ship angles, 13*l.* 15*s.*; iron ship rivets, 19*l.* 10*s.*; packing iron and steel (parallel), 13*l.* 10*s.*; packing iron and steel (tapered), 15*l.* 15*s.*; steel bars (no test), 15*l.*; steel ship plates, 11*l.* 10*s.*; steel ship angles, 11*l.* 2*s.* 6*d.*; steel boiler plates, 12*l.* 10*s.*; steel joists, 11*l.* 2*s.* 6*d.*; and heavy sections of steel rails, 10*l.* 17*s.* 6*d.* It is not known what is to happen to the Russian orders for rails, but it is understood that the execution of such work has been suspended.

Coke.—Whilst there is no actual shortage of coke, supply is none too plentiful, and in fact, the heavy home needs are not satisfied without difficulty. Average blast-furnace kinds are 33*s.* at the ovens, and qualities low in phosphorus 35*s.* 6*d.* at the ovens; whilst foundry cokes are 38*s.* for home use. For shipment to neutrals foundry descriptions are 45*s.* f.o.b., and gas house products 38*s.* to 40*s.* f.o.b.

INDUSTRIAL MANAGEMENT.—A course of six lectures on "Industrial Management" commenced at the School of Technology, University of Manchester, last Tuesday, and is to be continued on the 29th inst., February 5, 12, 19 and 26, at 4.30 p.m. The lecturers are Professor G. Unwin, Mr. H. T. Hildage, M.Inst.C.E., Mr. G. W. Daniels, M.A., B.Com., and Mr. T. H. Pear, B.Sc.

SHIPBUILDING IN SWEDEN.—Although the figures are not very imposing yet, there is no doubt but that the Swedish shipbuilding industry has received a great impetus through the war. During 1917, there were launched vessels of an aggregate tonnage of 29,000 registered tons gross, against 25,000 tons in 1916 and 20,000 tons in 1915. In 1917, there were also launched three warships and several submarines. The Swedish yards, of which both the capacity and the number have been much increased of late, have orders in hand for about 300,000 tons. It is hoped that the shortage of raw materials will not further increase the cost of building materials.

SHIPBUILDING AT SEATTLE.—Seattle saw the launching, on the last Saturday in November, 78 days after the laying of the keel, of the first ship to be completed on a contract for the Government's emergency fleet. The ship is an 8,000 ton standardised steel merchantman with a speed of 11 knots, and is one of 54 of the same size under contract. In the preceding three weeks of November 13 other new ships were completed for the Government. Some of the ships, when completed, are turned over by the shipping board to the Army and Navy, some go to the Italian and French Governments for transporting munitions and supplies to their troops, and some are entrusted to private shipping companies under an arrangement to assure excess profits to the board. In the four months ended March 1, 1918, the fleet corporation expects to complete 1,000,000 tons of shipping, which are urgently needed.

NOTES FROM THE SOUTH-WEST.

CARDIFF, Wednesday.

The Local Markets.—Although generally speaking there has been no improvement in the position of the Cardiff coal market, the inland demand is good, and in the case of gas coals exceeds the supply. The financial results of production are causing the owners some anxiety, and pressure has been brought to bear on the authorities to increase prices. A revised schedule is now expected, but if French and Italian supplies are again to be excluded from the operation of increased rates, this will very greatly militate against any advantages which may be derived from a revised scale, as South Wales depends so much upon its export trade—much more so than any other coalfield in the United Kingdom. It transpires that one of the reasons why the supply of gas coals is not so good as it had been expected it would be by this time is that the Glamorgan County Council made it impracticable for one of the gas-coal collieries to accept an offer of a temporary arrangement for the supply of extra labour from a neighbouring district. The company had practically arranged with motor-'bus owners at Bridgend to run early morning 'bus services to the South Rhondda Colliery, when the County Council intervened with a notice that the company would be held liable for an unstated proportion of the cost of the maintenance of the county road. The company did not see their way clear to incur this uncertain financial liability, and the colliery is, therefore, denied the use of the available labour till some permanent arrangements can be made with the railway companies.

Newport.—Stocks have been accumulating to a very considerable extent recently, and are now probably greater than they have been at any time, and even inland distribution is being adversely affected by the increasing scarcity of wagons, and colliery managers are at their wits' end to find facilities for banking small coals. The result is that both in the Eastern and Western Valleys pits have had to put up with intermittent stoppages.

Slack Time at the Collieries.—No intimation has yet been received as to the action which will be taken by the Coal Controller to mitigate the evils resulting from irregularity of work at some of the collieries. The proposal of the miners to introduce a five-day working week has meant that the issue has assumed quite a new phase. Colliery owners are anxious that such a far-reaching innovation should not be adopted at the present juncture, as it would prove no remedy of the evil, and would prevent that elasticity which is all-important in these days.

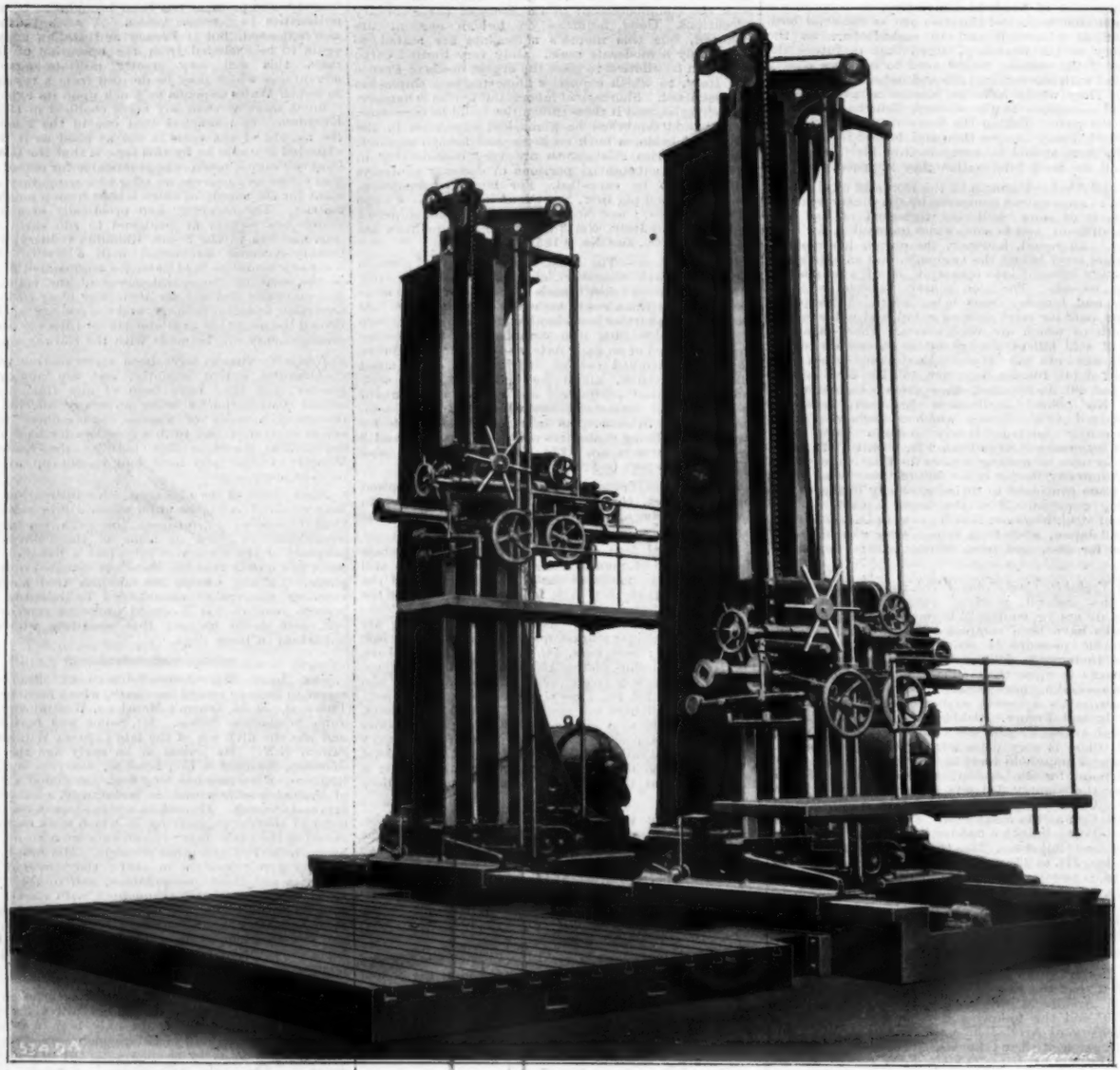
THE LATE MR. JOHN SCUDAMORE SELLON.—We regret to have to record the death, which occurred on the 18th inst., at 35, Queen's Mansions, Westminster, of Mr. John Scudamore Sellon. Mr. Sellon was born in 1836, and was the fifth son of the late Captain William Baker Sellon, R.N. He joined at an early age the firm of Johnson, Matthey & Co., London, assayers and metallurgists. His name has long been associated with those of leading scientific men in metallurgy, chemistry, the arts and sciences. He took an active share in the development of electric engineering, in which work he was associated in the early days of electricity with Faure, Brush, Swan, Lane-Fox and other pioneers. His first electrical patents were taken out in 1881; they covered storage batteries and their manipulation, and in that year he fitted out his residence throughout with electric lamps coupled to batteries. Mr. Sellon was for several years vice-chairman of the Electrical Power Storage Company, and vice-chairman of the Anglo-American Brush Electric Light Corporation, now the Brush Electrical Engineering Company.

GERMAN IRON.—A report from Saarbrücken states that the recent rumours of higher prices for various iron products have no doubt only been feelers. The prices at the latter end of 1917, which were agreed upon with the war ministry as maximum prices for the producer and the trade, will remain in force for the first quarter of 1918. The number of orders in hand in all branches of the heavy iron industry is as great as ever and will keep the works fully and profitably employed for months to come, without considering fresh specifications. Shortage of rolling-stock causes occasionally a certain scarcity of coke, which may interfere with the running of the works to their full capacity. The result is that deliveries to ordinary consumers, which are already slow, are further protracted. The monthly demands for pig-iron are much in excess of the quantities despatched, and complaints are loud from all quarters. There are no stocks of any moment in sections, I and U bars, at the works or at the merchants. In the bar iron market the same high degree of employment continues which has ruled for months past. Wherever possible, considerable quantities are disposed of to neutral countries in industrial exchange, and at highly remunerative, officially fixed prices. The home consumption absorbs all that is left and could do with larger quantities, although the present production is put at a very high figure, but, as already mentioned, the home demand is very active. In heavy plates the necessary quantities can be supplied within a comparatively short time. The precarious state as regards the market for plates of medium thickness, thin and galvanised sheets, has somewhat improved. For some time the trade has received supplies, based upon their previous requirements, and such supplies meet with a ready sale. Gas pipes can at present be obtained, whilst other kinds are used in large quantities by the military authorities. The same applies to wire and wire nails. All kinds of scrap is in strong demand, and prices remain unaltered for the first quarter of 1918.

5-IN. SPINDLE DUPLEX BORING, DRILLING AND MILLING MACHINE.

CONSTRUCTED BY MESSRS. G. AND A. HARVEY, LIMITED, GOVAN, GLASGOW.

(*For Description, see Page 92*).



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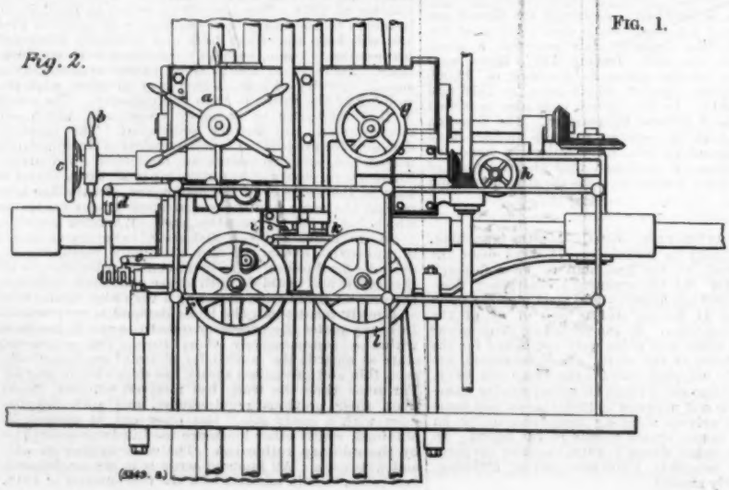

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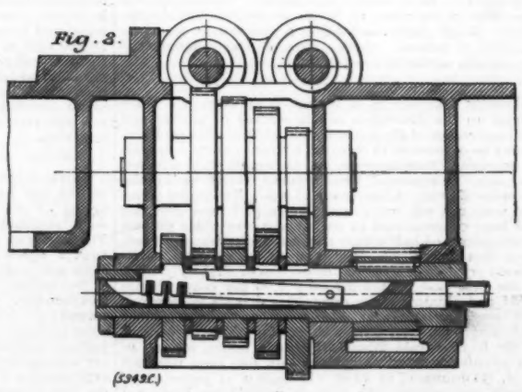

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The charge for advertisements is three shillings for the first four lines or under, and eightpence for each additional line. The line averages seven words. Payment must accompany all orders for single advertisements, otherwise their insertion cannot be guaranteed. Terms for displayed advertisements on the wrapper and on the inside pages may be obtained on application. The pages are 12 in. deep and 9 in. wide, divisible into four columns of 2¼ in. in width. Serial advertisements will be inserted with all practicable regularity, but absolute regularity cannot be guaranteed.

Advertisements intended for insertion in the current week's issue must be delivered not later than 5 p.m. on Thursday. In consequence of the necessity for going to press early with a portion of the edition, alterations for standing advertisements should be received not later than 1 p.m. on Tuesday in each week.

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Thick ,, ,,	£2 5 0
For all other places abroad—	
Thin paper copies	£2 5 0
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We desire to call the attention of our readers to the fact that the above is our SOLE ADDRESS, and that no connection exists between this Journal and any other publications bearing somewhat similar titles.

TELEGRAPHIC ADDRESS } "ENGINEERING," WESTRAND, LONDON.
TELEPHONE NUMBERS—3863 and 8596 GERRARD.

CONTENTS.

	PAGE		PAGE
The Sciotoville Bridge (*Illus.*)	81	The late Sir John Wolfe Wolfe-Barry (*With Portrait*)	95
Bicentenary of D'Alembert (1717–1783)	83	Aircraft Engines	98
The Economics of the Chinese Railways (*Illus.*)	84	Liquid Films	98
Traction on Bad Roads or Land (*Illus.*)	86	The Institution of Mechanical Engineers	99
Society of Glass Technology	88	Notes	100
The Siemens-Schuckert Concern	89	Industrial Notes	101
Applying the Brinell Tests (*Illus.*)	91	German Petroleum Industry	102
Wheel-Forging Press (*Illus.*)	91	The Value of Superheated Steam in Locomotives	102
5-in. Spindle Duplex Boring, Drilling and Milling Machine (*Illus.*)	92	The Production of Ductile Tungsten	102
Year-Books and Annuals	92	Aircraft Construction	102
Notes from the North	92	Utility of Motor-Tractor for Tillage Purposes	103
Notes from South Yorkshire	93	Automatic Magnetic Clutch (*Illus.*)	104
Notes from Cleveland and the Northern Counties	93	The Iron Ore Deposits of Russia	105
Notes from the South-West	93	ENGINEERING Patent Record (*Illus.*)	107

With a Two-Page Plate of the SCIOTOVILLE BRIDGE OVER THE OHIO RIVER.

NOTICES OF MEETINGS.

THE NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—Friday, January 25, at 6 p.m., in the Lecture Theatre of the Literary and Philosophical Society, Westgate Road, Newcastle-on-Tyne. An address will be delivered by the Right Hon. C. Addison, P.C., M.P., the Minister of Reconstruction, on "Trade and Industrial Reconstruction." Admission to the Hall will be by ticket only.

THE PHYSICAL SOCIETY OF LONDON.—Friday, January 25, at 5 p.m., at the Imperial College of Science, Imperial Institute Road, South Kensington, S.W. Presidential Address, by Mr. C. V. Boys, F.R.S.

THE ROYAL SOCIETY OF ARTS.—Monday, January 28, at 4.30 p.m. Cantor Lecture.—"High-Temperature Processes and Products," by Mr. Charles R. Darling, A.R.C.Sc.I., F.I.C., Lecturer in Physics, City and Guilds Technical College, Finsbury. Lecture II: "High Temperature Processes." Wednesday, January 30, at 4.30 p.m. Ordinary meeting.—"The Manufacture of Margarine in Great Britain," by Sir William George Watson, Bart., Chairman of the Maypole Dairy Company. Sir Arthur D. Steel-Maitland, Bart., M.P., will preside.

THE MIDLAND INSTITUTE OF MINING, CIVIL AND MECHANICAL ENGINEERS.—Thursday, January 31, at 3 p.m., at the Queen's Hotel, Leeds. The following paper will be read:—"Face Conveyors," by Mr. H. C. Jenkins. The following paper will be open for discussion:—"On the Splitting of Coal Seams by Dirt Partings." Part I.—"Splits that Rejoin," by Professor P. F. Kendall, M.Sc., F.G.S., Leeds.

THE ROYAL INSTITUTION OF GREAT BRITAIN.—Friday, February 1, at 5.30 p.m. A discourse will be delivered by Professor A. S. Eddington, F.R.S. The subject is "Gravitation and the Principle of Relativity." Afternoon lectures next week at 3 p.m. Tuesday, January 29. Professor W. M. Flinders Petrie, D.C.L., Litt.D., F.R.S., on "Palestine and Mesopotamia; Discovery, Past and Future" (Lecture III). Thursday, January 31. Sir Napier Shaw, LL.D., F.R.S., on "Illusions of the Atmosphere; Revolving Fluid and the Weather Map" (Lecture I). Saturday, February 2. Mr. M. P. H. Loyson, on "The Ethics of the War" (Lecture I).

NOTICE.

Owing to the recent Government restrictions, and to the enormous increase in the price of paper occasioned thereby, the Proprietors of "ENGINEERING" are compelled to advance the price of this Journal from 6d. to 8d. per copy. This increase dated from and included the issue of Friday, March 16. The change will not apply to unexpired subscriptions.

NOTICE TO NON-SUBSCRIBERS.

In view of the restrictions now imposed by the Government on the importation of paper, and of the consequent shortage of supplies, readers who wish to be sure of obtaining "ENGINEERING" each week should place an order for the Journal with a newsagent or bookstall clerk. Owing to the scarcity of paper it will be impossible in future fully to provide for a chance demand for this Journal.

ENGINEERING.

FRIDAY, JANUARY 25, 1918.

THE LATE SIR JOHN WOLFE WOLFE-BARRY.

It is with very deep regret we record the death, on Tuesday night last, of Sir John Wolfe Wolfe-Barry, K.C.B. By his decease there is removed from the domain of engineering enterprise one who, by his most varied ability, wide experience, sound judgment, and untiring energy typified in the fullest degree the accepted qualifications of the civil engineer, and represented in all his practice the highest traditions of the profession. That he directed the great sources of power in Nature for the use and convenience of man the many works for which he was responsible clearly prove. His railway and harbour works, and other undertakings to facilitate transport, were important influences in the development of the international trade which has been so conducive to the progress of the industries and well-being of all countries. He realised, too, from his training and experience, that the fundamental law of engineering, involving the conservation of energy, as well as the utilisation of Nature's power, could be extended to the everyday life of the people. It was only characteristic of him that he should repeatedly urge a solution of the problem of street congestion, with its immense wastage of time, and therefore of money; that during the railway strike he should counsel the public to dispense with unnecessary journeys; and that while the coal strike was in progress fuel should more than ever be economically used, even by those who could afford to pay excessive prices. Associated with his technical experience was a judicial mind, and thus he was a most successful arbitrator, while as a Parliamentary witness he was ever most helpful. The honour and dignity of the profession found in him a jealous guardian and an unfailing exemplar. To young engineers he gave readily of advice and encouragement. Indeed, it would be difficult to overrate his influence, direct and indirect, upon the profession, alike in its incorporated and individual capacity. This influence, too, will continue a living force.

Sir John was in his eighty-second year, having been born in London, on December 7, 1836, the fifth and the youngest son of Sir Charles Barry, R.A., who was the architect of the new palace at Westminster, now the Houses of Parliament. The family is a remarkable one. Of his elder brethren, the Rev. Alfred Barry became Bishop of Sydney and Primate of Australia; another was a Royal Academician, like his father; a third was a well-known architect.

The first part of Sir John's education was acquired at Trinity College, Glenalmond, where his elder brother, the Rev. Alfred Barry, was sub-warden. A broadly-devised curriculum was gone through; there was no attempt to specialise until he entered King's College, London. After completing his course there he served for some time in the employment of Messrs. Lucas Brothers, engineering contractors, gaining experience of practical work. It was after this that he became articled to Mr. (afterwards Sir) John Hawkshaw, by whom he was employed as assistant resident engineer in connection with the building of Charing Cross and Cannon-street railway bridges over the Thames, and the railway stations at their northern ends, and on other important works in hand at the time. In 1867, when thirty-one years of age, Sir John began business on his own account as a consulting engineer, and from this date onwards he was identified with some of the most important engineering works carried out in this country, either in a designing, executive, or consultative capacity. From 1878 the late Mr. H. M. Brunel was a partner with him, and continued to be associated in many works until his death in 1903. For seventeen years, from 1892 until 1909, the late Mr. C. A. Brereton was also a partner. Mr. G. E. W. Cruttwell and Mr. K. A. Wolfe-Barry were associated with him in partnership since 1901, and Mr. A. G. Lyster since 1913.

It is not possible within reasonable limits of space to review at length in chronological order the work for which Sir John was responsible. As we have already said, his services were, perhaps, more closely identified with facilities for transport than with any other branch of engineering. First place may be given to railways in and around London. Indeed, the impress of Sir John's work is clearly obvious to the informed student of the map of our capital. We have already indicated that before he was thirty years of age he was engaged in the work of carrying the South Eastern Railway across the Thames into Charing Cross and Cannon-street Stations, the former between 1860 and 1863, the latter between 1863 and 1866, while between 1877 and 1880 he designed and carried out, among other works, the Earl's Court Station for the Metropolitan District Railway Company, the extension of the Metropolitan District Railway to Ealing and Fulham, and, further afield, the Lewes and East Grinstead Railway for the London, Brighton, and South Coast Railway Company, on which he was engaged from 1878 to1883. In conjunction with his old friend, Sir John Hawkshaw, he was engaged from 1879 to 1884 on the lines for the completion of the inner circle between the Mansion House and Aldgate station, including the extension to Whitechapel. This work, it will be readily recognised by those who know the district, involved problems of considerable difficulty, due particularly to the underpinning of foundations of street buildings. Between 1883 and 1887 he was responsible for the carrying out of the St. Paul's Station for the London, Chatham, and Dover Railway, and the construction of the iron-arched bridge across the Thames at Blackfriars, to carry additional lines from the southern to the northern side of the river in supplement to the original lattice-girder bridge completed in 1864, to the designs of Messrs. Cubitt and Turner. With this last named exception he was responsible for, or connected with the construction of, all the railway lines over the river east of Westminster.

While he was engaged on the last of these railway bridges the problem of a road-bridge east of

London Bridge was exercising the authorities of the City of London, and he was called in to advise, in association with the late Sir Horace Jones, on this important work, the result being the construction of the Tower Bridge, which was completed in 1894. The bascule system for the opening span was early decided upon, and as the Thames Conservators insisted that the bridge should be kept open for vessels for two hours at or near the time of high water, the additional high-level bridge was introduced in order to maintain continuity for pedestrian traffic. But the admirable character of the designs for operating the bascules, and the fact that they can be opened and closed in less than five minutes, has rendered the use of the upper bridge almost unnecessary, and now it is closed. Sir Horace Jones died soon after the commencement of the work, so that the carrying out of the undertaking rested almost exclusively with Sir John. In the execution of the work, one of the important problems was that of determining the load which could safely be imposed upon the London clay; no engineer knew more of the substrata of the Metropolis than the subject of our memoir. In connection with the foundations of the bridge, it is interesting to state, as indicative of his method of tackling such problems, that he carried out extensive experiments, and he found that from about 1 ton per sq. ft. every increment of load produced a more or less observable subsidence. It was perfectly regular, and not at all alarming, but still the fact remained generally that as the load on a plastic material is increased from a comparatively small amount, there is a certain increment of subsidence as weights are added. The load on the Tower Bridge foundations was nearly 4 tons per sq. ft., and with that load the subsidence gradually increased up to 3¾ in., as weight was added in building the structure. The foundations of the Charing Cross Bridge, with which Sir John had had something to do in his early days, carried a heavier load—about 8 tons per sq. ft.—neglecting the large relief due to skin friction of the gravel and earth surrounding the cylinders, which extend to a depth of about 35 ft.

In connection with the Tower Bridge, too, Sir John made very careful observations on the subject of wind pressures, and was largely influential in the official change of attitude of the Board of Trade on this subject in the direction of accepting the view that anything over 56 lb. per sq. ft. may be regarded as most exceptional. One other bridge over the river was designed and constructed by Sir John and his partners—the King Edward the Seventh Bridge at Kew,* built during 1898 and 1903.

His other work in London included the Metropolitan District Mansion House and Whitechapel Stations, on the Inner Circle Railway already referred to, and the subway at South Kensington, constructed in 1884 and 1885. Between 1896 and 1900 he was engaged also in the widening and improvement of the Metropolitan Railway between Finchley and Harrow.

It was about this time that the electrical working of railways attracted Sir John's attention. He did not profess to be an electrician, but in connection with the working of railways and with engineering generally he naturally gave much attention to the general problems of electric traction. So convinced was he of its suitability for urban and suburban traffic that in 1899 he succeeded in persuading the two Metropolitan companies to allow him to make a temporary experimental and demonstration installation of electric plant, and to work the trains between Earl's Court and High-street, Kensington, on which there is a steep gradient and heavy curves. This, it will be noted, was before the Central London Railway had been completed, and the heaviest trains then operated by electric traction were those on the City and South London line. The Metropolitan trains weighed 180 tons when light and 230 tons when loaded. In the report that he presented to the two companies electric traction was supported, and it was pointed out that the trouble of greater vibration in electric, as compared with steam, traction had been overcome, the form of motor having been changed and the method of carrying it upon springs having been adopted. His argument was that as such urban railways cost from half a million sterling to 700,000*l.* per mile, it was important, in the interests of economy, to get the maximum revenue, and this was more easily ensured by electric than by steam traction. It was, however, some years before his persuasion had the desired effect.

His dock work in the Metropolitan area was also very extensive. He was responsible for all the extensions of the Surrey Commercial Docks between 1895 and 1906, and these were of considerable importance. Between 1897 and 1899, too, he carried out improvements at the Limehouse Docks of the Regent's Canal, and built the Limekiln Wharf.

Of his works in the provinces, perhaps the most important were those carried out in South Wales, and from this point of view there can be no doubt that he exercised a great influence on the prosperity of the coal and shipping industry. From 1885 it might almost be said that he was continuously engaged on the construction of the Barry Dock and railway systems. Owing to the great range of tide, the locks required to be of exceptional depth. The character of the strata, too, involved great care. This was particularly the case, too, in connection with the erection of the towers for loading the colliers. These usually rose to a height of 100 ft., and in some cases had to be built on extremely soft mud, the foundations being carried to depths of 40 ft. and 50 ft. Here again it was characteristic of Sir John that he should carefully experiment with the carrying power of the mud. He found that after the gradual application of smaller loads had occasioned definite subsidences proportional to the loads applied, a further additional load, raising the pressure to 2 tons on the square foot, produced a movement of the test-loads almost similar to their sinking in a viscous fluid, not merely a gradual compression of the soil, but a sudden disappearance of all resisting power. In his opinion the movement of such plastic soils, when the limiting power of resistance had been reached, was much like that of a fluid. By spreading the foundations of the towers over a very large base, so that in no place was there a load of more than about 1 ton on the square foot, the desired security was obtained, and neither the towers nor the machinery which these supported, and which is in constant vibration, and carries very considerable loads, have ever shown the slightest signs of settlement. The Barry Dock, opened in 1889, has an area of 73 acres at high water, and there is railway connection with all the coal-producing valleys. The entrance lock is 647 ft. long, 65 ft. wide, and 60 ft. deep. The further extension, completed in 1898,* included a new dock with an area of 40 acres. Two still larger graving docks have also been constructed at the port. At Newport, also, extensive works have been carried out for the Alexandra Dock and Railway Company; but as we have so recently referred to these works,† there is no need here to say more as to their extent. In connection with the new docks at Avonmouth for the port of Bristol, which were completed in 1908, Sir John was consulting engineer jointly with his late partner, Mr. C. R. Brereton, the late Sir Benjamin Baker, and the late Mr. C. A. Hurtzig. These docks were also described in ENGINEERING at the time of their completion.‡

It would be difficult to name a port in the country where, either directly or indirectly, as executive or consulting engineer, Sir John had not some influence; but here we must content ourselves with reference to the more important works. The new entrance to the Tyne Docks absorbed much of his attention between 1891 and 1895. In 1898-1907 he was engaged on the Middlesbrough Dock extension and the construction of a new entrance. From 1898 to 1908 he constructed an entirely new dock system at the port of Grangemouth, on the Firth of Forth. Later he designed and carried out the lock entrance, dock, and graving dock at Immingham, near Grimsby.* In 1889 he was appointed by the Board of Trade a member of the Ribble Navigation Commission, which included also Admiral Sir George Nares and the late Sir Charles Hartley, for the settlement of important engineering and financial questions connected with the estuary of the Ribble and the approach to the town of Preston. He was chairman of the Lower Thames Navigation Commission appointed by the Board of Trade in 1894, the other members being again Sir George Nares and the late Mr. G. F. Lyster. He was also a member of the Royal Commission on the Port of London from 1900 to 1902.

For Ireland and the West of Scotland he did much useful work. He was a member of the Royal Commission on Irish Public Works, appointed in 1886, and a member of the Western Highlands and Islands of Scotland Commission, appointed by the Secretary of State for Scotland in 1889. The report in both cases resulted in important legislation in connection with branch light railways, as well as fishery harbours, in both countries. One indirect result in Scotland was the extension of the Callander and Oban Railway, northward of Ballachulish, to serve not only the fishery interests, but the slate quarries there. This railway, carried out between 1898 and 1904, involved the construction of a large cantilever bridge at Connell Ferry.† Among the other railway works in recent years was the Shortlands and Nunhead line, built between 1890 and 1892.

As regards work abroad, he was one of the consulting engineers for the Government of Natal, was consulting engineer for the Bengal-Nagpur Railway, for the Bombay Port Trust, and for various railways in China. He was connected in each capacity with important works, carried out in India, China, and Natal, prominent among them being the Durban Harbour Works. In this connection it may be noted that he was the representative of His Britannic Majesty's Government on the International Consultative Commission of Works of the Suez Canal between 1892 and 1906, his colleague from this country being the late Sir Charles Hartley.

Possessed not only of a very wide experience in railway work, as we have already shown, Sir John had an aptitude for the business side of affairs, having a well-balanced shrewdness, which enabled him to adjudicate aright contending interests. He was thus, particularly in his later years, looked upon as a sure guide, and was consulted by governments, railway companies, and corporations very extensively. He was consulting engineer to the Caledonian Railway, and in this was was directly associated with important work in Scotland, including the construction of the Glasgow Central Railway and the Lanarkshire and Dumbarton Railway, with its eastern extension. He was also the consulting engineer for the North-Eastern Railway, the London, Chatham, and Dover Railway, and the Metropolitan and the Metropolitan and District Railways, in all of which capacities he rendered valuable national service in connection with transport facilities. He was a member of the Court of Arbitration, along with Sir E. Fry and Sir Hugh Owen, under the Metropolitan Water Act, 1902, in connection with the purchase of the company's undertakings in London for absorption by the Metropolitan Water Board. He was a member of the Royal Commission on Accidents to Railway Servants in 1899–1900; of the Commission of Inquiry into the Vibration in Tube Railways, along with Lord Rayleigh and Professor (now Sir J. Alfred) Ewing, in 1901–2; of the Royal Commission on the Traffic of London in 1903–5. He and his partners made a special report to Lord Shuttleworth's Royal Commission on Canals and Waterways in 1906.

Sir John gave liberally of his time, energy, and thought for the promotion of the interests of engineering, principally through the Institution of Civil Engineers. He was elected a member in 1868,

* See ENGINEERING, vol. lxxv, pages 662 and 739.

* See ENGINEERING, vol. lxi, pages 147, 214, 280, 339, and 397.

† See ENGINEERING, vol. xcviii, pages 33, 111, 177, and 217.

‡ See ENGINEERING, vol. lxxxv, page 857, and vol. lxxxvi, page 5.

* See ENGINEERING, vol. lxxvii, pages 653 and 717.

† See ENGINEERING, vol. lxxvi, page 152.

appointed to the Council in 1883, chosen a vice-president in 1893, and occupied the presidential chair in 1896–7. He was elected an honorary member of the Institution in 1916. His first contribution to the Proceedings was made in the year of his election as a member, and dealt with the City Terminus Extension of the Charing Cross Railway. For this he was awarded the Telford Medal and Premium. Twenty-seven years later, in 1895, he, in collaboration with Sir Benjamin Baker, contributed a paper on the Metropolitan Railways. He frequently took part in the discussions, and all his contributions were useful, owing to the fulness of his experience, which was freely narrated. He had, further, the facility of stimulating discussion by enunciating topics and questions regarding which definite information was desirable, either from the author or from those capable of giving information. He usually touched the weak spot, either from the point of view of reasoning or insufficient information, and by this means increased the value of the Transactions of the Institution. Perhaps, however, his greatest service was in inculcating the importance of a higher standard for election to membership, and thus, in his first presidential address in 1896, he enforced the maintenance of a high status by narrowing the portal through which each member entered. His second presidential address was almost entirely devoted to this theme, and the direct consequence was the establishment of a qualifying examination for the election of associate members and members. The nature of the qualifications, so far as Sir John conceived them, could easily be understood from the close reasoning of his address in connection with the blending of scientific and practical work. He enforced the view that the object to be gained by pupilage to an engineer in practice was not science education, but the learning how to apply knowledge to the various problems practically brought before the pupil. He set, as he said, a value on the important matter of practical knowledge and the cultivation of the factor of common-sense. We might almost say that his whole life was a demonstration of this view. "Education" and "instruction," he felt, were not comparable terms. "Education" implied that general exercise of the mind which brings out the best qualities of the human understanding, and enables it to acquire and assimilate special instruction. Thus he contended that the qualifying test must be concerned not only with book or purely scientific knowledge, but with experience in practical work. So long as the associate member and the young member have full value in marks for their practical work, and so long as the Institution, or those responsible, can gauge the worth of the older applicants for membership by their practical achievements, rather than their ability to manipulate figures, the examination system must continue to be acceptable and valuable.

It was during Sir John's presidency in 1897 that there was instituted the practice of having summer conferences of the Institution every second year, so that country members might have the opportunity of participating in a consideration of, and of exchanging views upon, various questions of professional interest. Sir John was connected with many other institutions. He was elected an associate of the Institution of Surveyors in 1868, and became a member of the Council in 1885. His membership of the Institution of Mechanical Engineers—an Institution to the interests of which he devoted much time and to which he rendered most valuable services—dates from 1871; in 1901 he was elected a member of the Council, and in 1913 he became Vice-President, a position which he resigned in 1915, although still retaining a seat on the Council. In 1893–4 he was President of the Junior Institution of Engineers. He was made a Fellow of the Royal Society in 1895. He was also a Member of the Royal Institution and a Fellow of the Royal Geographical Society. In 1898–9 he was chairman of Council of the Royal Society of Arts. In addition to his many contributions to the various institutions, he was the author of a book on railway appliances, published by Longmans in 1876 as one of a series of text-books of science. In 1877, in conjunction with Sir Frederick Bramwell, he delivered a series of lectures at the School of Military Engineering at Chatham, on the railway and the locomotive, and these were subsequently published by Messrs. Longmans in permanent form. The Honorary Degree of Doctor of Laws was conferred upon him by the Glasgow University in 1896. In 1897 he became Knight Commander of the Bath, his Companionship having been granted in 1894, in connection with the opening of the Tower Bridge.

Maull and Fox, Photographers.

J. Hopkinson

He worked, with great effect, for the advancement of technical education, and it was largely through his influence that the City Guilds became in recent years more intimately identified with this work. In 1895 he had been presented with the honorary freedom of the Turners' Company, in recognition of his work in connection with the Tower Bridge; but it was with the Goldsmiths' Company that he was more closely associated, and he was Prime Warden in 1912. For many years he was chairman of the executive committee of the City and Guilds Institute, and in this connection did great service for education. It was only natural that when the Government, in 1897, appointed a Committee to consider the desirability of establishing a National Physical Laboratory, Sir John should be appointed a member. Since the foundation of the Laboratory he has been a member of the executive committee. In 1900 he was, on the nomination of the Crown, made a member of the Senate of the University of London, and in 1907 was elected a member of the governing body of the Imperial College of Science and Technology.

Of even greater tangible value was the work he did in connection with the Engineering Standards Committee. It was on his initiation that the Council of the Institution of Civil Engineers in January, 1901, appointed a committee to consider the advisability of standardising various kinds of iron and steel sections. He was a member of the Committee of which the President of the Institu-

Institution at the time was made chairman, but on Mr. Mansergh's retirement owing to ill-health, Sir John, almost by natural selection, succeeded, and up to the time of his decease continued to direct the multifarious activities of the Committee with great skill and stimulating force. Of the ramification of the work it would be difficult to set a limit, while the practical value of the standards decided upon is cumulative in its effect.

In view of the leading part taken by Sir John in the development of the work of the Engineering Standards Committee it was most appropriate that he should have been invited last year to deliver before the Institution of Civil Engineers the James Forrest Lecture,* taking as his subject "The Standardisation of Engineering Materials and its Influence on the Prosperity of the Country." In this lecture he traced the history of the Engineering Standards Committee and gave a mass of valuable and interesting information regarding the work which it had carried out and the far-reaching effects of that work. How greatly the success which has attended the action of the committee has been due to the personality of its chairman can only be fully known to his colleagues in the work, but by them it will ever be remembered and appreciated. During the past year steps have been taken for strengthening the legal status of the Committee by incorporation, and in defining the details of these arrangements the advice and assistance rendered by Sir John have been invaluable.

Sir John took little part in political life; he was a Churchman and a Unionist. He was a strong advocate of Lord Roberts's movement for National Service. He had been one of the earliest members of the Queen's Westminster Volunteer Battalion, and was a colonel in the Engineer and Railway Staff Corps.

It will be recognised from our brief record that Sir John spent not only a long, but an exceedingly active, life. He greatly contributed to the commercial prosperity of the United Kingdom. He advanced the science of engineering in relation particularly to transport facilities. He helped to raise the profession to a higher status, and assisted to win from governments, corporations, and the public generally a recognition of the hall-mark conferred by membership of the great Institutions. Moreover, he showed throughout a singleness of purpose in giving freely of his time and experience for the general good of the community by service on commissions, and in utilising every opportunity to inculcate principles whereby the natural wealth and physical energy of the nation may be economised. Sir John in 1898 assumed by Royal Licence the additional surname of Wolfe. He is survived by his widow, Rosalind Grace, youngest daughter of the Rev. E. E. Rowsell, Rector of Hambledon, Surrey, a brother of Sir John's mother. He was married in 1874, and had four sons and three daughters, all of whom survive.

The funeral will take place on Saturday, the first part of the service being at St. Margaret's Church, Westminster, at 10.30 a.m., and the interment will be at Brookwood Cemetery.

AIRCRAFT ENGINES.

In our issue of January 4 last we drew attention to the fact that many able and well-informed engineers were seriously perturbed by our relatively low output of aircraft engines. Events have shown that the necessity for drastic action in this matter had already been realised by the new authority which assumed control of our air services last New Year's day. Amongst the earliest steps was the appointment of a committee to make a thorough revision of the accepted list of engines, and to reduce it from a figure of the order of some dozens of different makes and varieties to not more than four. Of course this work of eliminating the less suitable types must necessarily take time, but we are much relieved to learn that substantial progress is being made and the orders recently placed are confined to four patterns. Existing contracts for other types cannot, of course, be cancelled offhand. Such a course would lead to a serious, even if temporary, shortage of engines, as it is impossible to provide at once, and to every firm the drawings and gauges required for building the new patterns.

In this, as in all other departments of engineering it is necessary to effect a reasonable compromise between two conflicting ideals. Standardisation leads to a greatly augmented rate of production, but simultaneously makes it correspondingly more difficult to effect the improvements which steadily increasing experience may show to be possible. Cases could readily be cited in which attempts at standardisation of machinery on the basis of inadequate experience have proved well nigh ruinous, and the departments concerned were undoubtedly wise in the first instance in leaving open a wide field for invention and improvement. The result of this has been that our best engines are claimed to be two years ahead of the best produced by the enemy, which in true Teutonic fashion have been developed along humdrum lines. The gain in the useful load carried by an aeroplane increases as the square of any reduction effected in engine weights; and this is at last being realised by the Germans, who are now experimenting with lighter types of engine. No doubt the policy pursued by us in the past was continued too long, and gave rise to very serious misgivings on the part of those who realised that quantity as well as quality will be necessary to meet this year's efforts of the Hun. A certain inertia in large departments is, however, inevitable. Few offices, moreover, escape the blighting influence of men without technical knowledge being put into positions of authority where they either overrule on their own initiative the best efforts of their able subordinates, or act as perfect non-conductors in preventing any direct interchange of ideas between the technical staff and the official heads of their departments.

It was the knowledge that certain men of this class were in positions of authority in the Ministry of Munitions, and that they were obstructive of the efforts of their very capable engineering subordinates, which led us, in our article of the 4th inst., to make certain reflections on the staffing of the department. One of these, we wish frankly and without qualification, to withdraw. The difficulty has not been the absence of very capable engineers, experienced in internal combustion engines and in modern methods of manufacture, as the department has been able to secure the assistance of men of the highest reputation in these regards. The real trouble has been that important posts were held by men distinguished no doubt, in certain fields, but too unversed in technical questions even to understand the nature of the reforms urged on them by their engineering subordinates, much less to pass them on intelligibly to their own chiefs. We trust and believe that the recent re-organisation will abate this heavy handicap on the work of the department and give the engineers a freer hand.

The intention of the Air Board is, as stated, to stimulate output to the utmost by reducing the number of standard types to not more than four, and we trust that the opportunity will be taken to simplify details so far as this is practicable without loss of efficiency. At the same time, however, it is rightly considered imperative that the march of improvement shall not be unduly obstructed by over emphasis of the importance of output rate. The Royal Aircraft Factory is to be devoted exclusively to experimental work, but we are glad to learn that such work is not to be confined to this one establishment. It is all-important that several totally independent centres of thought shall be at work on the improvement of aircraft.

Exception has been taken to the suggestion in our article that sufficient attention has not been paid to the views of pilots. Judging from what happens in other services, the point is perhaps well taken. An excellent pilot may be a very indifferent engineer; he may have very clear ideas as to the aim to be attained, but may not be a reliable guide as to the best means to the end. An undue deference to the views of pilots and executive officers would, we admit, hardly have tended to hasten the standardisation of types.

* See ENGINEERING, vol. ciii, p. 432.

LIQUID FILMS.

THE first Friday evening discourse of this season was delivered at the Royal Institution last Friday by Sir James Dewar, F.R.S., on "Studies of Liquid Films." When lecturing on the same problems in the opening discourse of last year, Sir James had concluded his lecture by pleading for the continuation of research work in the laboratories of the Royal Institution; that work was threatened by the restriction of the departmental staff. In his introductory remarks of last Friday he was able to state that his two assistants remained with him, but they had been so much occupied in helping various Government departments that little time had been left for systematic research, which it was difficult to pick up again after frequent interruptions.

Briefly recapitulating, Sir James explained that their soap bubbles were blown with solutions of various soaps—ammonium soaps in quantitative chemical experiments because the determination of ammonia by Nessler's reagent was convenient, or soaps of the other alkali metals including caesium—containing up to 55 per cent. of glycerin, and with various gases. The absence of dust, and especially of greasy dust specks, which would reduce the surface tension, was essential for the long life of the bubbles. The liquid of the bubbles drained off continuously, and the films became thinner and thinner, the beautiful colours changing into silvery white and finally into black, the black film was visible only by a fluorescence and by reflecting the light. At the same time water vapour—the vessels in which the bubbles are produced always contain some water—was condensed on the film and absorbed by the glycerin, and the soap was thus washed out of the film, until the film practically consisted of water (98 per cent. of water in one case); this dilution proceeded regularly, rapidly at first, then slowly. The gas pressure inside the bubble was always a little greater than the pressure outside. Owing to the surface tension the bubbles contracted, and the gas was forced outward through the film; the nature of the gas did not affect the stability of the film unless the gas (*e.g.*, carbon dioxide) reacted chemically with the soap. The contraction was slow in large bubbles and quicker in smaller bubbles of greater curvature, the rates of contraction and of gas transference being inversely as the diameter of the bubble. We reproduce some of the figures from Sir James' tables, slides of which were exhibited. The diameters D of the bubbles were given in centimetres; the internal pressure P signified the excess pressure in the bubble, measured in millimetres of mercury; the rate of transference R signified the gas transferred in cubic centimetres per square centimetre of bubble area per day. The bubbles were blown in air. We combine several series of experiments in one table. The liquid of series I contained 50 per cent. of glycerin and 2½ per cent. of caesium soap; in series II 20 per cent. of glycerin and 4 per cent. of alcohol were in the soap solution.

—	I.			II.		III
Diameter D ..	6	7	8	10	12	38 cm.
Internal pressure P	0.3	0.26	0.23	0.18	0.15	0.05
Rate of transference R..	0.065	0.035	0.03	0.15	0.11	0.015

The next two series of experiments were made with hydrogen bubbles; in series IV the film was black, *i.e.*, as thin as it can be obtained; in series V the film was yellow and thicker. It will be seen that the amount of gas transferred was greater in the case of hydrogen than in the case of air, especially with the yellow bubble.

—	Hydrogen, Black Film Bubble. IV.			Yellow Bubble. V.		
D	6	8	10	4	6	8
P	0.3	0.23	0.18	0.55	0.36	0.28
R	0.253	0.218	0.19	0.285	0.103	0.05

In order to produce large bubbles of long life, Sir James continued, he had attempted to purify one of the cellars of the building of all dust, and to blow bubbles from outside through the wall; the cool, steady temperature of such a space would

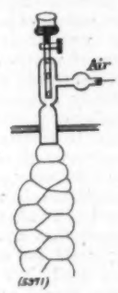
be an advantage for the experiments, which were disturbed by the heat and light beams of the lecture theatre; but he had failed in these attempts. Yet he had produced and exhibited films, half black, and another wholly black, in a bottle, 0.5 m. in diameter, and also large black bubbles; one of these films had lived for 56 days in spite of all the vibrations of the laboratory. Bubbles were more difficult to preserve, and their spontaneous contraction could be prevented by two methods, both of which had been applied: by replenishing the gas forced out of the bubble, and by producing the bubble in an atmosphere at high pressure, the pressure being high both inside and outside the bubble. Showing a bubble in a glass vessel at 10 atmospheres, Sir James pointed out that ten times the amount of gas would have to get through the film to produce the same contraction as would result in a container at 1 atmosphere pressure, and hence that bubble did not appear to contract; in a container at 100 atmospheres the bubble would practically be permanent. A bubble produced under diminished pressure, on the other hand, contracted almost visibly. The flask used for this experiment was closed by a cap provided with two bores; through the one bore entered the blow tube, which was bent outside the flask so as to form a lateral pocket for a little soap solution, introduced through a stopcock from above; the gas in the bottle, air or other gas, was rarefied by the aid of the tube passing through the other bore; the flask thus contained rarefied gas and water vapour. By tilting the flask while momentarily opening the stopcock, a very small amount of air was admitted through a capillary tube, and a little soap solution flowed down the blow tube, producing the bubble, which could be seen to contract. Still more striking was the next experiment. A soap film divided a cylindrical vessel into two compartments; the space on the left was filled with hydrogen, into the space on the right a little air was admitted. The image of the film was thrown on the screen where it showed as a black line; when the air was admitted, that line travelled to the left, because the hydrogen diffused through the film over to the right at a more rapid rate than the air diffused through it in the opposite direction.

The following table exemplifies the rates of transference of hydrogen through bubbles under pressures of 1 atmosphere and of 6.5 atmospheres. The first row again gives the diameters D of the bubbles in centimetres; the second the internal pressure excess P in millimetres of mercury; the third row expresses the P as fraction of the total pressure of 1 atmosphere, the fourth row as fraction of 6.5 atmospheres, in both cases with the coefficient 10^{-6}; the two last rows indicate the rate of gas transference R as before:—

D		4	6	8
P		0.0331	0.022	0.0166
Fraction of total pressure	1.0 atm.	43.6 ..	27.0 ..	21.5×10^{-6}
	6.5 ,,	6.7 ..	4.5 ..	3.25×10^{-6}
Rate R ..	1.0 atm.	0.22	0.15	0.10
	6.5 ,,	0.0825	0.041	—

Sir James then proceeded to demonstrations of the beautiful soap-bubble studies which Joseph Plateau initiated in 1842* and continued in spite of his blindness and the imperfect means at his disposal; his bubbles were very sensitive as the disturbing factors were not understood then. Plateau also experimented with drops of oil immersed in mixtures of liquids of the same density as the oil, in order to evade gravitation troubles (Sir James has also experimented on these lines) but he merely mentioned that similar experiments with soap bubbles would be very difficult, as they required gaseous media. Plateau had dipped skeleton crystals made up of thin wires into soap solutions and had studied the peculiar shapes the films assumed; these experiments were shown. When a cube is dipped into soap and withdrawn one should probably expect that the six cubical faces would be covered by films. That, we believe, is the first momentary effect. But the films, Sir James explained, are pulled inward and united in such a way that the centre of the cube was taken up by a small square film (or a small cube), and that, looking at a cubical face, one saw four films joined to a truncated pyramid, the top of the pyramid being the little square. Similarly, the films of a tetrahedron contracted inward so as to meet in the centre of the tetrahedron at angles of 120 deg. In the case of an octahedron there were 12 kite-shaped films crossing and meeting four small trigonal films, making altogether 16 films.

Sir James then approached the problems in another way. Forcing air through a tube he produced a soap bubble on a plate of glass smeared with glycerin; the bubble was more or less hemispherical. When a second bubble was planted next to the first, the two united with a plane, common face; a third bubble added led to the formation of three common faces meeting at 120 deg.; and so on. When the plate was illuminated from below to show the arrangement in the plan, it was seen that five bubbles would group themselves about a pentagon, six bubbles would form a hexagon, &c.; when the beam was sent horizontally through the bubbles, the beauty of their spherical and plane films could be seen. When the plate was blown upon; the films collapsed and flattened out, but the geometrical pattern remained discernible for a few moments. In order to study chains of bubbles, not resting on a plate, Sir James made use of another arrangement, which is roughly indicated in the annexed diagram. By manipulating the



stop-cock drops of soap solution are allowed to flow down a glass tube; this tube is jacketed with a tube to which the air pipe is joined; below the soap tube the jacket is provided with a stricture; lower down it ends in a cylindrical glass nozzle, after passing through the top of a square glass case, nearly 2 ft. high, in which the device is mounted. The drop of soap solution splashes on the constricted glass, the aperture of which is dimensioned so as to admit the right amount of air, and produces bubbles. The bubbles came out of the nozzle like a long string of sausages, sometimes regular, of fairly equal sizes, apart from small bubbles dancing about and draining visibly all the time (in the inverted beam image they seemed to spurt energetically), sometimes irregular and dividing into multiple chains. Double chains, as in the diagram, seemed frequently to be formed in striking regularity; but photographs of catenaries of strange complexity, built up of multitudes of bubbles yet in regular patterns, were also shown. The chains of bubbles, when supported below by a ring, could be pulled out and inclined, and displayed considerable elastic strength. When properly thinned out, the bubbles were black; by admitting a little more soap solution from above the silvery tint, and colours were then made to reappear. The photographs, Sir James remarked, had to be taken in sunlight—possibly because direct beam illumination would distort the images by too many reflections; stars of light shone on many of the bubbles. Some of the photographs in natural colours were particularly beautiful. They showed, *e.g.*, an inclined catenary in which both the spherical and the coloured plane faces were very distinct; in other multiple chains, black diamond faces stood out prominently from a mass of curved surfaces, visible only as black films, by their fluorescence. Very instructive were also the progress photographs. The first photograph of a series would show a string of bubbles of fairly equal sizes; on the second photograph the differences in sizes would be more marked, because the small bubbles had contracted more rapidly than the big bubbles; on the subsequent photographs the small bubbles would more and more vanish, the bigger ones uniting again, while even the latter had visibly shrunk.

Sir James concluded his discourse by quoting Roger Bacon. Bacon, who was very fond of referring to the ocean god Proteus, who could assume all shapes, had said that he, who would know the properties of water, would comprehend all that had been, that was, and that would be, although his knowledge would not extend to the individual beings. If water could by itself exist in this wonderful variety of shapes, Sir James remarked, the wonderful complexity of the shapes of living organisms ceased to be astonishing.

* See ENGINEERING, February 2, 1916 page 109.

THE INSTITUTION OF MECHANICAL ENGINEERS.

AN ordinary general meeting of the above Institution was held on Friday evening last, the 18th inst., at the Institution of Civil Engineers, Westminster, the president, Mr. Michael Longridge, occupying the chair.

NOMINATIONS OF OFFICERS.

The ordinary formal business of the meeting having been despatched, the president announced that in accordance with Article 23 of the Institution, the president, two vice-presidents and seven members of council would retire at the ensuing annual general meeting. The complete list of those retiring is as follows:—As president, Mr. Michael Longridge; As vice-presidents: Mr. William H. Allen and Mr. J. Rossiter Hoyle; as members of council: Sir J. Wolfe Barry, K.C.B., Mr. Walter Pitt, Sir J. Alfred Ewing, K.C.B., Dr. Edward Hopkinson (appointed during the year), Mr. H. A. Ivatt, Sir Henry J. Oram, K.C.B., and Mr. Richard Williamson (appointed during the year). All the foregoing, with the exception of Sir Alfred Ewing and Mr. Pitt were nominated by the council for election, with their consent. The following were also nominated by the council for election, with their consent:—As members of council: Mr. Daniel Adamson, Sir Henry Fowler, K.B.E., Mr. J. W. Restler, Mr. David E. Roberts, and Mr. William Taylor (Leicester). No other nominations being made, Mr. Longridge stated that the members eligible for election to the council would be those named in the above list.

The secretary then announced that four transferences had been made by the council that afternoon from the class of associate member to that of full member.

MOTOR TRACTORS FOR TILLAGE AND TRACTION ON BAD ROADS.

Two papers were set down for reading that evening, one entitled the "Utility of Motor Tractors for Tillage Purposes," by Mr. Arthur Amos, of the School of Agriculture, University of Cambridge, and the other on "Traction on Bad Roads or Land," by Mr. L. A. Legros, of Acton, member.

The president, prior to the reading of these papers, remarked that he invited Mr. Amos to read his paper first, inasmuch as it was in its nature introductory to the longer paper of Mr. Legros. Mr. Legros would not read his paper, but would deliver the substance in the form of a lecture, a course which the president believed would be of greater interest than reading the actual paper. As the reading of the two papers would occupy the entire evening, the discussion would have to be postponed until the next meeting.

Mr. Amos then read his paper, which we print in full in the present issue, page 103. Mr. L. A. Legros next delivered his lecture, which he accompanied by the exhibition of a number of extremely interesting lantern slides. We commence the publication of his paper on page 86 of this issue.

The president, in bringing the proceedings to a close, said that the Institution was greatly indebted to the authors, and he therefore proposed a hearty vote of thanks to both of them.

Mr. Longridge further announced that the discussion on the two papers would take place after the annual general meeting, to be held on Friday, February 15.

NOTES.

WATER POWER IN GREAT BRITAIN.

After referring briefly to the inquiry made by the Coal Conservation Sub-Committee of the Ministry of Reconstruction and to the saving in fuel which their scheme is likely to effect, Mr. A. Newlands, M.Inst.C.E., Engineer-in-Chief of the Highland Railway, in the course of a paper on "Water Power in Great Britain" (with special reference to Scotland) read before the Royal Society of Arts last Wednesday, stated that in considering the question of power it was sometimes forgotten that one cubic foot of water per second, falling 11 ft., gave one horse-power in any modern turbine, and no investigation into the power resources of the country was complete that did not include water power within its scope. It was most desirable, therefore, to consider to what extent water power could contribute to our local power requirements. Scotland, and in particular the Scottish Highlands, possessed more water power possibility than any other part of Great Britain. That part of Scotland was the most extensive mountainous region in the British Isles, and it had within it, as a whole, the highest rainfall, the only locality comparable with it as regards rainfall being Seathwaite in Cumberland, and Snowdon in Wales. An annual rainfall of 160 in. had been recorded on Ben Nevis, 182 in. in Cumberland, and 193 in. on Snowdon. Mr. Newlands had found that there was in Scotland, and chiefly in the Scottish Highlands, 11,500 sq. miles of country, or 42 per cent. of the total area, having a rainfall of 50 in. and over. He had endeavoured to arrive at an approximate estimate of the water power available in Scotland by the impounding of the discharge from the loch basins. For this purpose, he had assumed an average rainfall of 42 in., this, if uniformly discharged, represented a yield from catchment areas of 3 cub. ft. per second per square mile, which was a very convenient figure for approximate calculation. The fall available had been reckoned as that from the intake to the nearest point on the seaboard, or on the route of the Caledonian Canal, or the nearest line of railway, these being the localities where industrial works would most readily be laid down. Of the 42 in. rainfall, it was assumed that two-thirds, or 28 in. was available for power, and the author produced a map on which were marked the powers available at a very large number of places distributed over Scotland, assuming that the flow for 24 hours was utilised in 12 hours, the efficiency of the machinery being reckoned at 75 per cent. Since 14 in. was deducted from the assumed 42 in. this, together with any surplus over the 42 in., would be reckoned for evaporation and absorption, and for compensation to rivers. The powers on the map showed a total of 375,000 h.p. in round figures. By diversion and linking-up of adjoining catchment areas, and by impounding beyond the extent provided for in preparing the estimate, it might be assumed that for, say, 100 days' supply, 650,000 h.p. would be available in Scotland. The Clyde, Forth and Tweed basins had not been dealt with owing to the important water supply and other interests already involved, nor had the power possibilities of rivers and small streams been included. The over-all cost of development for horse-power could not successfully be generalised upon. A few data were given in the paper of the existing installations, among which was the one at the Kinlochleven works of the British Aluminium Company; the output of this plant was 150,000,000 units per annum, whereas the requirements of the London County Council were 97,000,000 units, those of Glasgow for tramways and lighting 63,000,000 units, and those for electric traction in the United Kingdom for 1909 253,000,000 units. Attractive possibilities existed in the stretch of the Caledonian Canal between Loch Ness and Inverness; another attractive area was that drained into Loch Luichart, near Strathpeffer, whilst the possibilities of Lochs Morie and Glass on the east shoulder of Ben Wyvis were worth investigation, as also was the elevated area between Glen Morriston and Glen Urquhart on Loch Ness. It would appear, therefore, that there was sufficient water power available in the Scottish Highlands to meet a large part of the demands of industrial and municipal requirements in Scotland, but, on the other hand, it was doubtful if the cost, after development of transmission to existing industrial areas, would be less than the cost of power generated there at the pit-head. But one of the most interesting features of Scottish water power was that it existed in a territory destitute of coal. In the case of rivers, the development of small powers from suitable streams was a relatively simple and inexpensive matter. In large rivers, however, it was difficult economically to utilise even a considerable part of the normal flow, owing to the cost of devising a cheap scheme for dealing with a large volume of water at the low fall normally available. Turbines for a head of 25 ft. cost 4*l.* per horse-power, as against 1*l.* per horse-power for a head of 500 ft. A high fall was the ruling factor in all economically developed water power schemes.

ISOPIESTIC SOLUTIONS.

The term isopiestic solutions which Mr. W. R. Bousfield, K.C., F.R.S., introduced at the December meeting of the Faraday Society in a paper of that title, is to designate (aqueous) solutions of salts which have the same vapour pressure (of water). The term was criticised because it is already customary to speak of equal hydrostatic pressures as isopiestic. Mr. Bousfield replied that his term referred to solutions, and it was preferable to similar terms, such as iso-osmotic, isohydric, isotonic, which all concerned aqueous solutions and the number of water molecules per molecule of salt, but were indefinite in so far as one experimenter referred to molecules of solution, and the other to molecules of solute, and chiefly because those other terms were not merely statements of facts, but were mixed up with some theoretical assumptions. Mr. Bousfield wished to correlate the number of water molecules h per molecule of solute, and when he said that aqueous solutions of potassium chloride, sodium chloride and lithium chloride were isopiestic at 18 deg. C., when $h = 12.43, 14.23, 17.18$ in the three cases, he meant that aqueous solutions of these salts, having stood for days in the same aqueous atmosphere until their vapour pressures were at equilibrium, would contain the stated numbers h of molecules of water per molecule of salt. It had not been easy to conduct these experimental determinations, he explained. He had first experimented in Torricelli vacua; this method being laborious, he had placed his solutions in various parts of a room, but had found slight temperature fluctuations too disturbing; he had also tried a slowly-turning table for his vessels. In the method finally adopted he placed four glass cylinders, 5 cm. diameter, 4 cm. deep, on a tin stand by means of which they could easily be lifted into and out of a Hempel desiccator. Each glass was furnished with a glass cover and a platinum stirrer; in the lid of the desiccator which was well ground, the joint being luted with vaseline, was a small trough, charged with water (or also a drying substance). Into each cylinder was placed a weight (2 grammes or 3 grammes) of a dry salt, the three mentioned salts KCl, NaCl, LiCl, and saltpetre KNO_3; and at intervals of about three days the glasses were re-weighed to determine the loss or gain of water, the water in the trough being replenished if necessary. In this way he found that both KCl and KNO_3 took up no water in forty-six days, when NaCl had taken up 9.08 molecules and was all dissolved, and LiCl (which is known to be hygroscopic) had taken up 11.40 molecules. The h values above quoted—KCl, 12.43; NaCl, 14.23; LiCl, 17.18—were observed after eighty-five days, when the KNO_3 was still quite dry. In fact, to find values for the saltpetre, Mr. Bousfield had to proceed in the opposite way, *i.e.*, start with an aqueous solution and observe the slow drying; this line of experiments, interrupted by the war, was not yet complete. His conclusion was that for each salt without water of crystallisation (such as the salts stated) there was, at a given temperature, a certain vapour pressure (critical hydration pressure) below which the dry salt surrounded by aqueous vapour would not take up water and would, if not dry, become dried. The matter is, no doubt, of practical interest for drying and concentration processes. But the method is not unassailable—we do not know which method would be—and its very delicacy suggests that the values obtained might not be of much value for the chemist working in draughty rooms with unequally-heated vessels. The discussion by Professor A. W. Porter, Drs. J. A. Harker, R. Lessing, Greenwood and Senter, moreover, draw attention to several puzzling, though fairly well-known, features. It is very difficult to dry a wet, small filter in a vacuum or to dry a solution in a deep (not shallow) basin; when phosphorus pentoxide is used as drying agent, some particles of the agent will be found perfectly dry after months, while others have melted; Professor F. T. Trouton found that silica and blotting paper absorbed salt from solution of sulphates, &c., up to a certain strength of the solution, but actually gave up salt to stronger solutions, and that the curve: salt absorbed and salt in solution, had two maxima, not only one maximum. All these facts show that the phenomena of the loss and absorption of moisture are very complex and proceed at a very slow rate.

INDUSTRIAL NOTES.

WITH reference to employment, wages, prices and disputes in 1917, the Director of the Department of Labour Statistics states in *The Labour Gazette* that, partly owing to the increasing numbers of men required for the Army and Navy, partly owing to the growing requirements both of these forces and of the Allies, and partly to the need of reinforcing vital industries, the demand for labour was never so great as in 1917. Women and girls were more extensively employed, dilution of skilled labour was carried further, and the movement of labour from one industry to another continued. In spite of all efforts, however, the demand for the classes of workpeople required was not fully met, and the transfer of labour on a greater scale from the less to the more essential industries is imperative in the national interest. A new feature in the situation is a certain amount of short time in some of the textile industries resulting from restricted supplies of raw materials. In these industries the great bulk of the employees are women and young persons, and it remains to be seen how far surplus labour of this kind can be utilised on other work.

The percentage of trade union members reported as unemployed was slightly higher than the abnormally low figure in 1916 owing to increased unemployment in the cotton trade after the Cotton Control Board's scheme came into force in September.

The following table shows the mean annual percentages of unemployment among trade unionists reporting to the Department in each of the years 1903–1917:—

	Mean of 12 Monthly Percentages.		Mean of 12 Monthly Percentages.
1903	4.7	1911	3.0
1904	6.0	1912	2.4*
1905	5.0	1913	2.1
1906	3.6	1914	3.3
1907	3.7	1915	1.1
1908	7.8	1916	0.4
1909	7.7	1917	0.7
1910	4.7		

* Average for ten months, omitting the two months affected by the general coal strike.

The mean monthly percentages unemployed of workpeople insured under the National Insurance Act, 1911, were 0.6 in 1917, compared with 0.6 in 1916, 1.2 in 1915, and 4.2 in 1914.

The upward movement in wages which commenced in 1915 was a marked feature of 1917, the amount of increase being far greater than in any previous year. All the principal groups of trades participated in the rise. The demand for labour and the rise in prices were mainly responsible for the increases in wages.

The number of workpeople (omitting seamen, railway servants, police, &c.) who were reported to the department as having received increases in rates of wages or war bonuses, during 1917, in the industries for which statistics are available, was nearly 4,700,000, and the total amount of increase in the weekly wages of these workpeople was nearly 2,200,000*l.*

In considering these figures, it is important to remember that they include increases granted not only to men, but to boys and women and girls. The amount of the advances granted to men has usually been greater than that given to females and boys and accordingly, if the average increase per head in the various trades be calculated, it will be affected by the proportion of male and female labour employed, and the average increase for men alone would be greater.

In several large groups of manual labour employ-

ments the numbers of workpeople affected by changes in rates of wages are not known, although the amount of the increase was reported. Consequently, such changes are not included in the above table. The rates of wages of agricultural labourers continued to rise, partly as a result of the rise in retail prices and the shortage of labour, and partly, in some districts, in consequence of the enactment for Great Britain of a minimum wage for adult able-bodied men, at the rate of 25*s.* per week, inclusive of the value of allowances in kind. The cash rates of wages of able seamen, and firemen on foreign-going vessels, which mostly ranged from about 7*l.* 10*s.* to 9*l.* per month at the beginning of 1917, continued to rise during the year, and in November uniform rates of 11*l.* 10*s.* for seamen and 12*l.* for firemen were agreed to by the recently constituted National Maritime Board, and confirmed by the Shipping Controller. The war "bonuses" for railway servants manipulating traffic were increased during the year from 10*s.* per week (men) and 5*s.* per week (boys) to 21*s.* and 10*s.* 6*d.* respectively, and converted into war "wages." Workmen and boys in the Royal Dockyards and in certain War Department establishments received increases corresponding with those granted in the engineering and shipbuilding trades generally; and the war bonuses of postal servants were substantially increased, by amounts varying according to the weekly wages. Increases were also made in the minimum rates fixed under the Trades Boards Act for workpeople employed in certain trades.

At the beginning of 1917 the general level of retail prices of the principal articles of food was about 87 per cent. above that of July, 1914; at the beginning of 1918 the corresponding increase was 106 per cent., so that the total increase during the year was about 19 per cent. on the prices of July, 1914, or about 10 per cent. on those of January, 1917. It may, however, be stated that by modifications in the dietary the general percentage increase between July, 1914, and January 1, 1918, instead of being 106 would be 59, this figure comparing with 47 for January 1, 1917.

With reference to items of expenditure other than food there have been substantial increases, except with regard to rents; but the average advance has not been so great as with food. The increase from July, 1914, to January 1, 1918, in the cost of all the items ordinarily entering into working-class family expenditure, including food, rent, clothing, fuel and light, &c., may be estimated at between 80 per cent. and 85 per cent., taking the same quantities of the various items at each date and eliminating advances arising from increased taxation, and between 85 per cent. and 90 per cent. if increases due to taxation are included.

The number of labour disputes causing a stoppage of work in 1917 was well below the average number for the nine previous years, but it was considerably in excess of the number in 1916. The total number of disputes recorded was 688, involving 820,727 workpeople, directly and indirectly, at the establishments concerned. The aggregate duration of these disputes amounted to 5,500,000 working days, or about one-half the average for the nine preceding years.

Speaking on Tuesday, the 15th inst., as president of the London Liberal Federation, at a gathering of the office-bearers of the different associations, in connection with the reorganisation of the London constituencies, Mr. Asquith said there was nothing in any lesson taught by the war to impair our faith in free trade. A second, and a not less vital matter, was that of the future relations between Labour and Capital. A solid foundation here had been laid in the report of the committee which he appointed eighteen months ago, and which was so ably presided over by Mr. Whitley. He was not one of those who thought that the experience of the war lent encouragement to the ideal of a general and direct control by the State of the production and distribution of commodities; but the elimination of what was now called "profiteering" on the part of those who were able to exploit for their own benefit, and at the expense of the community, what was or could be made a monopoly, offended no principle of justice or social expediency. What he ventured to commend to the meeting in this domain was not to enter into a controversy about generalities, but to grapple with particular cases—for the variety of conditions was almost infinite—always remembering and upholding the root principle of Liberalism, that special privileges, special classes, special interests must, upon due proof given, be subordinated to the common good.

Mr. G. H. Roberts, Minister of Labour, responding to the toast of the "Ministers of the Crown," at a dinner given on Wednesday, the 16th inst., by the Eccentric Club, St. James', to the First Sea Lord, Sir Rosslyn Wemyss, said he wanted to make it perfectly clear to the whole world that he would be no party to the disruption of the British Empire. The assurances of the British Crown would be ratified in due course. For anyone to tell him that the rule of the German Empire was at all comparable to that of the British Empire was as much as to tell him that the sun was the moon.

So-called manifestoes were being issued without the concurrence of the Labour movement and without the rank and file of that movement being consulted. He was a democrat, and he denied the right of any clique to speak in the name of the Labour movement with which he was connected unless all the various elements of that movement were being consulted and a ballot taken which could give a proper decision. We were told by some people that after the war we should help enemy nations to recover as rapidly as we did ourselves. He was sufficiently old-fashioned enough to believe that sin ought to be punished, and that wrong ought to be expiated. The Central Empires were alone responsible for the precipitation of this horrible catastrophe, and they ought not to be allowed to emerge from this terrible struggle without paying the full penalty. He knew that what he was saying might involve him in a parting of the ways, but he was a British citizen before he was a politician.

It had been suggested that we ought to help the enemy to recover quicker than our own nation, but he could not subscribe to any such theory. His view was "My own country first, and the British Empire in association therewith; the Allies next." We must arrange with ourselves and our Allies before we had any regard to the others.

It was because he wanted the working classes of this country to obtain a sufficiency to know and enjoy life that he was not prepared to enter into trade or friendly relations with the Central Empires. If he had his way, they should go into the wilderness for generations for purification and purging before they were again admitted into the comity of civilised nations. Our soldiers and sailors were fighting and killing the men, not because they wanted to kill but because they knew the Central Empires which these men represented were the great barriers between the human race and the enjoyment of things that were held dear by all freedom-loving people.

The Iron and Steel and Kindred Trades Central Advisory Committee (Operatives), which has recently been appointed to advise and assist the Ministry of Labour with regard to questions arising in the administration of the Employment Exchanges which affect workpeople in these trades, held their second meeting at the Employment Department on the 18th inst. The committee considered further the proposal that Employment Exchanges should give preference, other things being equal, to men who have been discharged from His Majesty's forces through wounds or other disabilities, when submitting applicants for vacancies. Whilst expressing general sympathy with the proposal, the committee thought that it was a matter which might usefully be discussed at a joint meeting with the corresponding committee of employers. The committee further resolved that the maintenance by firms of private employment exchanges not working in close co-operation with the National Employment Exchanges is unsatisfactory. The question of the opening of new Employment Exchanges and Local Offices of the Unemployment Fund in South Wales was also raised, and the committee received a report of the work of the Employment Department.

Since the issue of the notice reproduced on page 74 *ante*, the Government have had under consideration questions that have arisen in regard to classes of workmen claiming the benefit of the Orders under which the bonus to munition workers has been given, and on this matter the advice of the Committee on Production has been obtained. After careful consideration of this advice and of the whole position, the War Cabinet have decided to adopt the following as a settlement of claims made in regard to the bonus:—

1. The 12½ per cent. has been given, under existing Orders and extensions thereof made by the Admiralty and the Minister of Munitions, to workmen employed on munitions work (as defined in the Munitions of War Acts) and paid as plain time workers in engineering shops, boiler shops, foundries, shipbuilding and ship-repairing establishments, iron and steel trades, electricity generating stations and electrical contracting trades, nut and bolt trade, brass foundries and brass works, bridgebuilding and constructional engineering hollow-ware trade, spring-making works, hot stamping works, tube works, and wagon-building works.

2. As from the beginning of the first full pay week which followed January 1, 1918, a bonus of 7½ per cent. on their earnings shall be paid to all workmen of 21 years of age and over employed in establishments or trades (other than the iron and steel trades) covered by the existing Orders relating to plain time-workers or extensions thereof, and engaged on munitions work as defined in the Munitions of War Acts, who are piece-workers or are paid on a premium bonus system or any mixed system of time and piece, or any system of payment by results, including men working at augmented time rates fixed in lieu of piece rates or by reference to results or to output of work.

3. The 7½ per cent. bonus shall be paid as an addition to any other bonus or war advances payable to the men concerned under any agreements or awards. Provided that any bonus or war advance which in the case of time-workers has merged in the 12½ per cent. shall merge in the 7½ per cent., and that no workman shall receive the 7½ per cent. bonus who has already received in some other form some equivalent consideration for the 12½ per cent. bonus. In any case where payment has been made to workmen pending the general consideration by the Government of the position of men paid by results, the amount of such payment shall merge in the 7½ per cent. bonus now authorised, and such bonus shall, as from this date, be in lieu of and in substitution for any such other payment.

4. A special conference shall be called of employers and trade unions concerned in the iron and steel trades to consider the form in which this bonus shall be applied, having regard to the terms of settlement arrived at in those trades in relation to the 12½ per cent. bonus.

5. Any claims to participate in the 7½ bonus not already dealt with by paragraph 2 shall be settled by the Committee on Production after hearing the parties concerned under references from the Minister of Labour.

THE INSTITUTE OF METALS.—The annual general meeting of the Institute of Metals will be held in the rooms of the Chemical Society, Burlington House, W. 1, on Wednesday, March 13, and Thursday, March 14, 1918. The presidential address will be delivered and several papers read and discussed on March 13, whilst further papers, including the Fourth Corrosion Report, will be read on March 14. A detailed programme of the meeting will be issued next month.

CONTROL OF SPELTER.—The Minister of Munitions has extended the Order made by him on March 23, 1917, as to the control of spelter, and the expression "spelter" means, as from the 22nd inst., spelter of all qualities, and includes sheet and rolled zinc, scrap zinc, hard spelter, dross, zinc ashes, flux skinnings, zinc dust, zinc ore, zinc oxide, zinc sulphide (or lithopone) whether dry, in oil, or prepared for use, and zinc compounds of every kind, or any of them.

THE SNELL ECONOMIC SHIP.—A novel method of operating certain classes of overseas traffic is proposed by Mr. H. de M. Snell, M.Inst.C.E., in a pamphlet published by the Peninsular Engineering Co., Ltd., Suffolk House, Laurence Pountney Hill, E.C.4. The plan consists essentially in using one set of engines for a number of hulls. In cross channel cargo traffic the actual time of transit is but a few hours, whilst the time spent in port may be five or six days. With the system proposed by Mr. Snell a set of Diesel engines driving electric generators is fitted in a steel caisson, which also contains the engineer's quarters. This caisson is mounted detachably on the stern of any one of perhaps five hulls. These hulls are to be fitted with electric motors driving the screw, but with no other propelling machinery. On arrival at port, the whole caisson is to be lifted by pontoons from the hull of the incoming vessel and transferred to one about to depart. This operation can, it is claimed, be effected very rapidly by the use of special pontoons. As the machinery caisson is to be mounted on the stern of the hulls the whole of the propelling machinery is confined to the after end of the boat. It is claimed that with this arrangement more effective subdivision of the vessel is possible, giving greater security against torpedo attack.

THE INSTITUTE OF MARINE ENGINEERS.—The presidential address of Captain Richard H. Green, delivered at the Institute of Marine Engineers on the 15th inst., was largely reminiscent of Thames engineering and engine-repair work. Reference was made to some very rapid work done, particularly in boiler repair, since the outbreak of the war. One point of special note was Captain Green's plea that the Institute should materially assist those engaged in marine engineering work by taking an interest in, or even supervising, the training of engineering apprentices engaged in the repair shops. Captain Green said it had been a matter of considerable difficulty for employers in the past to ensure a proper educational standard for the boys while they were going through the shops. The education authorities had gradually grown aware of the necessities of this class of student, but he personally had always felt that an institute, like that of which he had the honour to be president, might very beneficially interest itself in supervising and examining the rising generation of marine engineers. Concluding, he paid a tribute to the marine engineers who, throughout the war, had shown such splendid examples of self-sacrifice and devotion to duty. Whether they were Royal naval engineers or members of the mercantile marine, they had one and all been subject to the perils of the war at sea, and one and all had, without exception, splendidly upheld the traditions of the British race in devotion to duty, even with the sacrifice of life.

"THE VALUE OF SUPERHEATED STEAM IN LOCOMOTIVES."

To the Editor of Engineering.

SIR,—It is to be hoped that in view of the interesting discussion now going on in the columns of your excellent Journal, some definite data may be established with regard to the above subject. There is no doubt whatever as to the advantages of superheating, but the "value" of superheating may be taken advantage of in three distinct ways:—

Method No. 1.—For a given coal consumption, the haulage capacity may be increased by the adoption of larger cylinders.

Method No. 2.—For a given haulage capacity a considerable saving in coal and water may be secured.

Method No. 3.—An exact balance between these two methods may be adopted; resulting in a slightly increased haulage capacity, and, at the same time, fuel economy to a limited extent.

As to which of these conditions it is best to adopt, depends, of course, on the requirements of the particular railway concerned. Many interesting points are raised in the letters of your previous correspondents. I agree with Mr. Brewer that it does not follow that because, say, 20 per cent. of the tubes be taken from a boiler, it will therefore make 20 per cent. less steam. The fire-box seems to have been overlooked in this connection. The value of a square foot of heating surface in the fire-box is at least equal to, if not better than, 8 sq. ft. of tube surface. It must be remembered that the fire-box remains the same whether the engine be superheated or saturated. It is a well-known fact that many locomotive boilers have been "over tubed" in the past. Superior results have been obtained with fewer tubes, suitably distributed, permitting of good circulation of the water. Mr. King's contention that in the case of two locomotives of equal weight, one superheated and the other saturated, the saturated engine would be the most powerful, is probably correct. Such an engine would, however, be extravagant as regards fuel.

Weight limitation, when engines are built to the extreme limits imposed by the traffic department, is a very important matter. The addition of a superheater equipment generally augments the weight of a locomotive from 1½ tons to 2 tons. This may prove serious in the case of two-cylinder engines, on account of the variations of rail pressure due to "hammer blow," unavoidably associated with the employment of two cylinders.

In the case of a balanced four-cylinder engine the added weight would not matter very much.

In conclusion, it would appear that the advantages of superheating are so manifest that to build a large main-line locomotive without superheater equipment would seem ridiculous.

Yours faithfully,

CHAS. W. DAUNCEY.

95, Ridgeway, Edgbaston, Birmingham,
January 19, 1918.

THE PRODUCTION OF DUCTILE TUNGSTEN.

To the Editor of Engineering.

SIR,—I trust you will forgive me for trespassing on your space again on the above subject, but it seems to me that the letter in your last issue signed by Messrs. Speechly, Mumford and Craig calls for a reply. Notwithstanding the remarks of that firm of solicitors, I think my original statement was substantially correct, and that it is proven by the following statement to the effect that "the total production of tungsten wire drawn at Rugby as evidenced by the production sheets was 5,835,686 ft." This amount, adopting the calculation of Speechly, Mumford and Craig, was ample for all the lamps made and sold by the British Thomson-Houston Company. The lamps imported from America were small in number (less than 1 per cent. of the British Thomson-Houston Company's total sales), and they were entirely special.

However, to satisfy Messrs. Speechly, Mumford and Craig and the amused lamp manufacturers I will correct my original statement so as to make it read as follows: "The British Thomson-Houston Company were supplying their whole requirements of ductile tungsten for lamp filaments in 1912 by manufacture at their Rugby works *from material some of which had been partly treated in America.*"

After all it is quite unimportant as to whether the whole requirements of the British Thomson-Houston Company were made at Rugby in 1912, 1913 or early in 1914, so far as my original letter on the *Daily Telegraph* report of Mr. Johnstone's lecture was concerned. What was material was that the British Thomson-Houston Company was manufacturing ductile tungsten before the outbreak of war. They had been manufacturing it from tungsten oxide for a long time prior to August 2, 1914, and, by the way, they started manufacture from tungsten ore mined within the British Empire, in the beginning of December, 1914.

Before closing this letter and the correspondence so far as I am concerned, I would like to express my surprise that Messrs. Speechly, Mumford and Craig should now use in this way information acquired from confidential works records, copies of which they obtained by process of law from the British Thomson-Houston Company in the case which they mention. These records were secured in an attempt by the defendants to bolster up a plea, which it would seem they were unable to prove, that the British Thomson-Houston Company had not been working Patent No. 21513* of 1906 to an adequate extent in this country. Presumably they could not support the plea for the issue was never tried, and although Mr. Fraser's affidavit may be a public document, the production sheets never became such. It may be of interest to state that the defendants were directed to pay the costs of the British Thomson-Houston Company on the issue.

The case is still *sub judice*, and the remaining issues decided upon by Mr. Justice Astbury and the Court of Appeal will be reviewed by the House of Lords at an early date.

I need hardly comment on the boastful paragraph at the end of Messrs. Speechly, Mumford and Craig's letter beyond saying that the British public may take comfort from the fact that at least two concerns in this country are each able to supply the whole of the demand for drawn tungsten filaments.

Yours faithfully,

JOHN GRAY.

83, Cannon-street, London, E.C. 4, January 22, 1918.

AIRCRAFT CONSTRUCTION.

To the Editor of Engineering.

SIR,—Mr. Comfort, in his letter in your issue of January 11, has slightly misunderstood the problem. The extra space of ¼ in. was not in the "gap" but between the top centre plane and top main plane where they are connected by joint rod.

The designed space of ¼ in. was thus increased to ½ in. owing to the box rib of top plane being placed out of position to the extent of ¼ in., thus shortening length of top plane by that amount, and reducing surface area by $4.5 \times \frac{1}{4} \times \frac{1}{12} = 0.05$ sq. ft.

The details of machine required by Mr. Comfort are:—

W = Weight of machine fully loaded allowing 140 lb. for pilot's weight = 1,442 lb.
A = Surface area of planes = 240 sq. ft. Angle of incidence, 2 deg.
k = Coefficient of efficiency of this particular machine not known.
The chord of plane = 4 ft. 6 in.
Area of box-rib side = 0.8 sq. ft.
Weight of strip of three-ply, 0.8×7 oz. = 0.4 lb.

Assuming for the moment that coefficient k and angle of incidence are unaffected (the latter cannot be), horse-power required for horizontal flight

$$= C_1 \times W \times \text{Vel.} = C_2 \times W \times \sqrt{\frac{W}{A}}$$

where C_1 and C_2 are constants.

We thus obtain:

1. Horse-power for designed machine

$$= C_2 \times 1442 \times \sqrt{\frac{1442}{240}}$$

2. Horse-power for faulty machine

$$= C_2 \times 1442 \times \sqrt{\frac{1442}{239.95}}$$

3. Horse power with three-ply added

$$= C_2 \times 1442.4 \times \sqrt{\frac{1442.4}{240}}$$

The increase of horse-power required for horizontal flight in (2) and (3) is obviously inappreciable.

The efficiency of the plane may be somewhat affected by the increased eddies or currents due to increased space.

What I desired was to obtain the opinion of experts whether it was worth while to make any correction at all in the faulty plane.

Considering the variation in different pilots' weights it would seem that the error might be safely neglected.

Yours faithfully,

D. GEORGE.

7, Stanhope-terrace, Hyde Park, January 17, 1918.

GERMAN PETROLEUM INDUSTRY.

THE German Petroleum Company has decided to pay a dividend of 8 per cent. for each of the last two years, 1915–16 and 1916–17. The company had expected to reap the full benefit of the boom which the war brought for so many industries, including the mineral oil industry, but the happenings in Roumania and the havoc wrought on the Steaua Romana concern frustrated these plans. It has been possible to reopen a number of old bore-holes which had been blocked up, and new boreholes have also been made, some of them already being productive. This more especially applies to borings undertaken jointly by the Steaua Romana and the German Rockoil Company, principally on property belonging to the State of Roumania. The results have on the whole exceeded expectations. The balance sheet for 1915–16 contains the accounts of the Steaua Romana for 1915, which year was reduced to 7½ months. For the first time a dividend on the year of 16 per cent. was attained. No dividend for the Steaua Romana was included for the year 1916–17. The European Petroleum Union could not issue a balance sheet for 1915 either, as no reports could be obtained from the affiliated companies in hostile countries. All its interests in American petroleum undertakings had been disposed of to good advantage. The very valuable English selling companies of the European Petroleum Union, as well as the shipping company, domiciled in London, had, several months ago, been sold to the Anglo-Persian Oil Company, over which the English Government exercises the leading control, but so far it had not been possible to ascertain at what price. The Austrian petroleum undertaking, the Vulkan and the Fortuna concerns, have been energetically developed and acquired a number of new concessions. The capital invested in the Austrian undertakings now amounts to about 10,000,000 kr. (400,000*l.*). The German Petroleum Company, which in the spring of 1915 acquired a number of shares in the German Rock Oil (Erdöl) Company, have since increased their holdings, which may now be looked upon as a permanent investment. Of other investments may be mentioned shares for 4,000,000 kr. in the Hungarian Natural Gas (Erd Gas) Company and shares in the Deep Boring Technique and Motor Construction Company. The company's holding of shares in other concerns amounted to 29,863,825 marks on September 30, 1917. The dividends for the last two years, referred to above, of 8 per cent., are the same as the one declared for 1914–15.

The Austria Petroleum Industry Company, Vienna, which embodies the Austrian production, refining and transport interests of the German Rock Oil (Erdöl) Company, has drawn up a report for the last four years, which includes the periods of military disturbances in Galicia. In spite of the difficulties which had to be encountered the company is now able to pay its shareholders 30 per cent. dividend, equal to 7½ per cent. dividend for each of the four years in question. The undertakings of the German Rock Oil Company in this connection are four refining establishments and the mines of the Premier Petroleum Company, formerly the Premier Oil and Pipe Line Company, but the Olex Company is outside this arrangement. The share capital now amounts to 12,000,000 kr. (480,000*l.*), having been increased by 2,000,000 kr. in 1916, most of which capital is held by the German Rock Oil Company, which in 1915 wrote off 6,000,000 marks and in 1916 further 830,000 marks on their Austrian holdings, partly owing to harm done by the Russians and partly owing to the fall of the Austrian exchange; at the end of 1916 the holdings in question, after the revenue from the Premier transaction, stood booked at 6,160,000 marks against 4,150,000 marks in 1915 and 10,150,000 marks in 1914.

The German companies had interests in Roumania, which, of course, suffered with other interests from the destruction done to the wells and plant. The present possessors of the Roumanian oil fields are working hard to increase the production which is much needed by the Central Powers. A considerable proportion of the normal peace output has been reached from some of the old concerns, the Astra Company, the Steaua Company and the Concordia Company, all of which are being worked under their own management. The Roumanian Consolidated Oilfields Company, an English concern, is being worked under German or Austrian management, as is also the Romana-Americana Company. As doubt prevails as to the continued yield of the old concerns, it was deemed expedient to make trial of new districts—in the first instance the oilfields belonging to the Roumanian State, which were at one time on the point of being transferred to the Standard Oil Company, and which for other reasons in the meantime had been left unexploited. The German military authorities have now taken the matter in hand, and a syndicate has been formed, of the capital of which two-thirds have been found by the German Petroleum Company, and one-third by the German Rockoil (Erdöl) Company, which syndicate is undertaking the work on certain fixed terms. The opening out of the districts in question is now in progress, the two German companies each supplying engineers, material, &c., in proportion to their shares. The raw oil produced is delivered to the military authorities and by them distributed to the different refining concerns in the country, which also receive a good deal of raw petroleum from their own petroleum wells, both old ones put in order, and new ones recently bored. So as to facilitate the delivery of the petroleum to the Danube, and to relieve the railways from the transport in tank wagons, the new pipe line from Plœsti to Constantza Harbour is being diverted so as to touch the Danube, more to the west, at Giurgiu. Material results are expected from the new line, which it is thought ought to become a permanent link in the German-Roumanian petroleum traffic. The cost of recovering the pipe line and the pumping stations is stated to have been only small.

SCOTTISH ENGINEERING RESEARCH ASSOCIATION.—As a result of representations received from the Advisory Council of the Committee of the Privy Council for Scientific and Industrial Research, and of public meetings held in Glasgow, a joint committee of the Institution of Engineers and Shipbuilders in Scotland, and the West of Scotland Iron and Steel Institute, have prepared a draft memorandum outlining the proposed constitution for a Scottish Engineering, Shipbuilding, and Metallurgical Research Association. The matter being of national importance, a meeting was held in Glasgow on the 22nd inst., and the following resolution adopted: "That a Research Association, on the lines proposed in the draft memorandum, be formed, and that a committee be appointed to draw up a memorandum and articles of association in co-operation with the Advisory Council of the Committee of the Privy Council for Scientific and Industrial Research." The draft memorandum referred to proposes that the objects of the new association should include the following: (1) To promote research and other scientific work in connection with the trades and industries included within the scope of the association; (2) to apply for and accept grants from the Government for the purposes of the association; (3) to establish, form and maintain museums, collections, libraries, &c., and to translate, compile, collect, publish, lend, sell any literature, statistics and information in connection with the trades or industries concerned; (4) to encourage discoveries and inventions in connection with these trades or industries; (5) to establish, promote, co-operate with, receive into union or combine with any other bodies, or persons engaged or interested in similar research work, either in Scotland or elsewhere; and all such subsidiary powers as may be necessary for carrying out the objects of the Association.

UTILITY OF MOTOR TRACTORS FOR TILLAGE PURPOSES.*

By ARTHUR AMOS, of the School of Agriculture, University of Cambridge.

THE chief value of the motor tractor to the farmer is, that it enables him to get his ploughing done quickly when the texture of the land is best fitted for the work, instead of being compelled to continue ploughing with horses for long periods when soil and other conditions are not really fit. This gives the farmer two great advantages: first, the subsequent cultivations necessary to produce a seed-bed are reduced by perhaps 50 per cent.; and, secondly, if a field is ploughed quickly after the previous crop is removed, weeds are prevented from overrunning the land and are consequently more easily kept in subjection.

At this stage it may be well to state the three most important factors which determine the texture or friability of any soil (there are others of lesser importance). These are, first, the size of the particles composing the soil; if the soil consists mostly of large and coarse particles, then the soil is generally friable and easy to cultivate, as for example, sandy and gravelly soils; but if the particles are small then the texture becomes more tenacious and sticky, and friability is bad; such soils are generally called clays. Between these two extremes all intermediate types of soil exist. Secondly, texture depends upon the degree of wetness of the soil; most soils when wet (especially the clays) are characterised by a tenacious sticky texture, require greater power for cultivation, and become pasty if cultivated, so that, subsequently, they are difficult to convert into good seed-beds, because such a pasty condition prevents the clods from breaking. As the soil passes from a wet to a more dry yet "moist" condition, this sticky character disappears and the texture becomes more and more friable; in this condition the land is easy to plough, and the resultant ploughing is more easily converted into a good seed-bed. If, however, drying is continued and the soil becomes quite dry, it often sets so hard (especially on clay soils) that it becomes impossible to plough, and only very powerful cultivators, such as those drawn by steam engines, are able to break the land. This dry condition of hard texture of the soil, however, presents one very marked contrast with the bad texture due to excessive wet, namely, that when such dry, hard soil is broken up and subsequently becomes moist with rain, it crumbles into an ideal seed-bed like a lump of quicklime. At present there is no motor-drawn implement which is able to deal with this hard condition of clay land, but it is not impossible that some new implement may be devised to act as a cultivator for use with high-speed engines under such conditions. Thirdly, the texture depends upon the previous cultivation of the land, whether it has been recently cultivated, in which case the surface of soil cultivated is loose, or whether it has become consolidated by long weathering and the trampling of carts, horses or sheep; in the former case the furrow is more easily turned, but the loose surface presents greater difficulties to the effective grip of the tractor wheels on the land, and movement may be impossible; in the latter case the work of the tractor is increased, but, as in the case of a clover stubble, the surface is so firm and solid that the wheels obtain a good grip.

From these considerations it is obvious that motor tractors have to plough under a great variety of soil conditions, so that it is not to be expected that any one tractor will be the best under all circumstances. With this introduction, it is possible to examine some of the points of agricultural importance in the motor tractor.

Power.—It would seem hardly necessary to emphasize the importance of the tractor being possessed of ample power, but every one may not appreciate how greatly the power required for ploughing different conditions of soil varies. Perhaps the case is best illustrated by reference to horse ploughing; on some light land three horses will plough with a two-furrow plough 2 acres in a day, whereas on clay land three horses may only be able to plough half an acre a day. It follows that the ploughing of one soil may require four times the power required by the other, and a tractor that does good work on the one will fail completely on the other.

The logical conclusion from this would seem to be that one type of tractor should be designed for the light land and another for the heavy land, but whilst this may be carried into practice to some extent, it cannot completely solve the difficulty, for on very many farms some of the fields are composed of heavy and some of light land, and moreover in the same field the texture of the soil may suddenly change as one passes from one soil type to the next. These difficulties may be overcome, partly by using a plough with fewer breasts for ploughing heavy land, partly by changing speed when the soil varies, but much the most sensible solution of the difficulty is by fitting the tractors with engines capable of developing ample power for the work for which they are designed.

Weight.—The tractors in use in England at the present time vary greatly in weight, from about 20 cwt. up to 5 tons. From two points of view weight is advantageous, thus weight generally signifies greater strength in construction and less wear and tear; again, a heavy tractor can often obtain a better foothold than a light one upon the land over which it travels. On the other hand, a heavy tractor when used for ploughing suffers in comparison with light tractors in three distinct respects. First, a heavy tractor must consume a considerable portion of its power in merely transporting itself across the field, and this consumption of power increases very greatly when the surface is soft and the "going" is bad; secondly, the dead weight of the tractor is a very serious handicap upon hilly land, whether, as is usual, the ploughing is done directly up and down hill, or whether it is done across the slope, in which case the heavy tractor tends to slide down hill; thirdly, and this is the most serious reason agriculturally, a heavy tractor may do untold damage to the texture of the soil over which it travels. The author proposes to explain the conditions under which this damage to the texture of the soil occurs in some detail.

When the soil is dry, no matter whether it be a light or a heavy soil, the pressure of heavy tractor wheels on the soil occasions no damage to the texture of the soil, but when the soil is moist or wet then the pressure of the wheels tends to squeeze and paste the soil into a consistency resembling brick-earth "pug" (the condition into which brick-earth is worked before being moulded into the shape of bricks). This condition is fatal to the production of a seed-bed and to the growth of crops, and, if produced on heavy land, may take a rotation of crops (say five years) to rectify. On light soils this condition is much less likely to occur, and if it occurs can be much more quickly rectified.

On light soils generally, and on other soils in a dry state, therefore, a tractor weighing 3 tons to 5 tons may be quite inadmissible, but for ploughing heavy land or loams in moist condition such heavy tractors, unless provided with caterpillar wheels (and these do not obviate the damage completely), are unsuitable. For such ploughing, tractors weighing 30 cwt. or less are more suitable, and even these must be used with discretion; unfortunately, so far as the author is aware, only one such tractor with sufficient power, and this in very small numbers, is available.

The conclusions to be drawn from these remarks are twofold: First, that actual strength required in the construction of different parts of the tractor shall be accurately determined by experiment and not by guesswork; secondly, that when this is known, the framework shall be liberally composed of best steel instead of iron, so that weight may be reduced.

Speed.—Perhaps the most important factor upon which the rate of ploughing depends is the speed at which the tractor travels; the greater the speed the greater the area accomplished; consequently, it is desirable to obtain as high a speed as possible unless this advantage is counterbalanced by some disadvantage. A further reason for maintaining a comparatively high speed is that the friction exerted between the soil, on the one hand, and the various parts of the plough in contact with it, is a function of the areas in contact at any one time and not of the length of furrow ploughed per unit of time; consequently, a plough hauled at a comparatively high speed experiences no greater friction than one hauled at a low speed. It should be, of course, stated that the plough does other work besides overcoming friction, which is not reduced by greater speed.

In the case of horse-ploughing the best speed is largely decided by the speed at which the horses can develop their greatest power, and this has been shown to be between 2 miles and 2½ miles (the normal rate of horse-ploughing is about 2 miles) per hour, as a result of this nearly all types of ploughs have been evolved to suit this speed, and it by no means follows that this form of plough is the best for ploughing at a speed of 3 miles or 3½ miles per hour, a speed at which tractors might well work; certain it is that some ploughs hauled at such speeds by motor tractors accomplish very bad ploughing. Nevertheless, because of the eminent advantages of this higher speed, it is desirable that both tractor makers and plough makers should consider these points, and test such problems experimentally.

Wheels and Grip.—When the surface of the land is dry and solid, tractor wheels experience little difficulty in obtaining an efficient grip of the surface, but when the surface is loosened by previous tillage or by wet weather, the difficulty of obtaining foothold is very great. A variety of devices have been tried for overcoming this difficulty, most of which may be classified under two headings: First, extending the area of contact between the wheel and the surface of the soil, and, secondly, by attaching grips or studs to the wheel surface so as to obtain greater friction.

The former of these objects may be obtained either by using driving wheels of large diameter or with wide tread, but the best method of improving the grip on this principle is by the so-called caterpillar wheels. Theoretically this is an ideal method of attaining the end in view, and in practice the method succeeds and gives to the tractor the best grip on a loose or slippery surface; but one practical difficulty arises, namely, that grit and dirt is always present in the bearings and working parts between the drive and the tracks, which consequently undergo rapid wear and tear. But because this method does give the best grip, and because it also enables the weight of the tractor to be distributed over a wider area, and thus prevents packing of the soil, it is worthy of extended trial and experiment to minimise this adverse feature of wear and tear.

The second means of overcoming slipping by means of grips or studs attached to the outside of the driving wheels needs careful consideration. It should be recognised that such studs or grips press upon the soil in two directions as the wheel revolves, partly by a vertical pressure and partly by a lateral pressure, and in general it may be said that the vertical pressure by consolidating the soil is harmful, whereas the lateral pressure has a stirring tendency which may be beneficial, especially when one driving wheel runs on the subsoil in the open furrow. It follows that blunt studs should be avoided, and that more pointed and perhaps longer studs or grips will occasion less damage to the soil.

In the case of the lighter motor ploughs and tractors, it is worth mentioning that the practice of running one driving wheel in the open furrow (provided it is not so wide as to press on the furrow already turned) is desirable, because in this position the soil during the ploughing season is firmer and generally drier.

Turning at Headlands.—One of the most serious drawbacks in the use of the motor tractor with the common type of multiple plough is the necessity for wide headlands; many of the tractors require one of from 6 yards to 10 yards according to the type of tractor, because they are unable to turn short. A further consequence of this is that the motor tractor has to travel a long distance along the headland, on the average 30 yards to 40 yards at each end, and cases are within the knowledge of the author in which in actual use the tractor has been running 80 yards and 100 yards along the headland at each end. Now the average length of plough furrow will be about 200 yards, and assuming the run along the headland averages 30 yards, the time lost at the headland will amount to one-seventh of the running time of the tractor. This is a very serious waste of time.

The difficulty does not arise in the case of steam ploughing, because for this purpose a balanced plough is used which simply requires to be toppled over at each end, and it seems to the author that no insurmountable difficulty would be experienced in designing such a three or four-furrow balanced plough for use with motor power. Such a motor plough would need to have the motor placed in the centre of the implement; it would need reverse gears similar and equal to the forward gears, and would need two sets of controls; the ploughs would be balanced before and behind.

The advantages of such a machine for purposes of motor ploughing are very great, some of the more important are enumerated below:—

1. Time lost in turning would be greatly reduced.
2. The headlands could be reduced to very narrow limits.
3. The headlands would not be crushed by frequent passage of the motor upon them.
4. The plough would start at one side of the field and work back and forward until the opposite side was reached. All the furrows would be turned in one direction; there would be no ridges, no open furrows, and no awkward narrow widths left for the horses to finish.

In conclusion, the author has tried to indicate some of the problems, partly agricultural, partly mechanical, which need solution in order that motor-tractor ploughing may become more efficient. There is, he believes, no public institution whose business it is to investigate such problems, and private firms have little time. It is to be hoped that the Board of Agriculture will shortly complete its scheme for founding an Institute of Agricultural Mechanism for research in, and testing of, new agricultural machinery, of which motor ploughs form only one branch.

* Paper read before the Institution of Mechanical Engineers, Friday, January 18, 1918.

PLUMBAGO CRUCIBLES.—The restriction of the plumbago exports from Ceylon, and still more the inhibited exports of the Klingenberg clay from Bavaria, has seriously interfered with the manufacture of plumbago crucibles in America. According to the *Engineering and Mining Journal* of November 3, 1917, it takes months to make crucibles and to obtain some information as to their suitability, and the first crucible made from plumbago and American clays did not prove satisfactory: the clays were not sufficiently uniform, and the crucibles stood only 5 heats instead of 25 and 30. Improvements have been effected, but the clays are still at higher prices than the imported clay was.

THE "LIBERTY" MOTOR.—We read in *Machinery*, New York, that the recently designed "Liberty" motor is shown by tests to be an especially efficient engine, and it will be used on all United States aeroplanes and motor trucks. The twelve-cylinder engine has surpassed the expectations of its designers. While the motor will be made with four, six, eight and twelve cylinders, the design allows the maximum interchangeability of parts. Although this motor has been developed largely by two engineers, one connected with the automobile industry and the other with aviation, it is a combination of the best features of engine designs, both American and foreign. It has been so designed that it can be manufactured cheaply in great quantity, and differs from the best foreign engines in the elimination of the great amount of handwork which the latter require.

MINERAL OIL FROM HOME SOURCES.—With reference to the production of mineral oil from home sources, and apart from very serious technical difficulties which have to be overcome, the competing claims of other urgent war services for labour and materials render impossible the rapid development of methods which might otherwise be pursued with advantage. The Ministry of Munitions, however, has been steadily pursuing the policy which is considered to be best designed to produce substantial results in the shortest time. All existing plant at the shale works of Scotland, and the gas works and coke ovens throughout the country are being pressed to their full capacity and are being extended as far as present circumstances permit. It has been found by experiments that certain plants already in existence can be adapted in a short time to treat new material by new methods. This adaptation of plants is being actively pursued and has the obvious advantage of saving labour, time and material, and making the best use of existing staff and equipment. On the other hand, where suitable raw material cannot be dealt with on existing plants, arrangements are in progress for erecting works for the extraction of oil.

AUTOMATIC MAGNETIC CLUTCH.

(*For Description, see opposite Page.*)

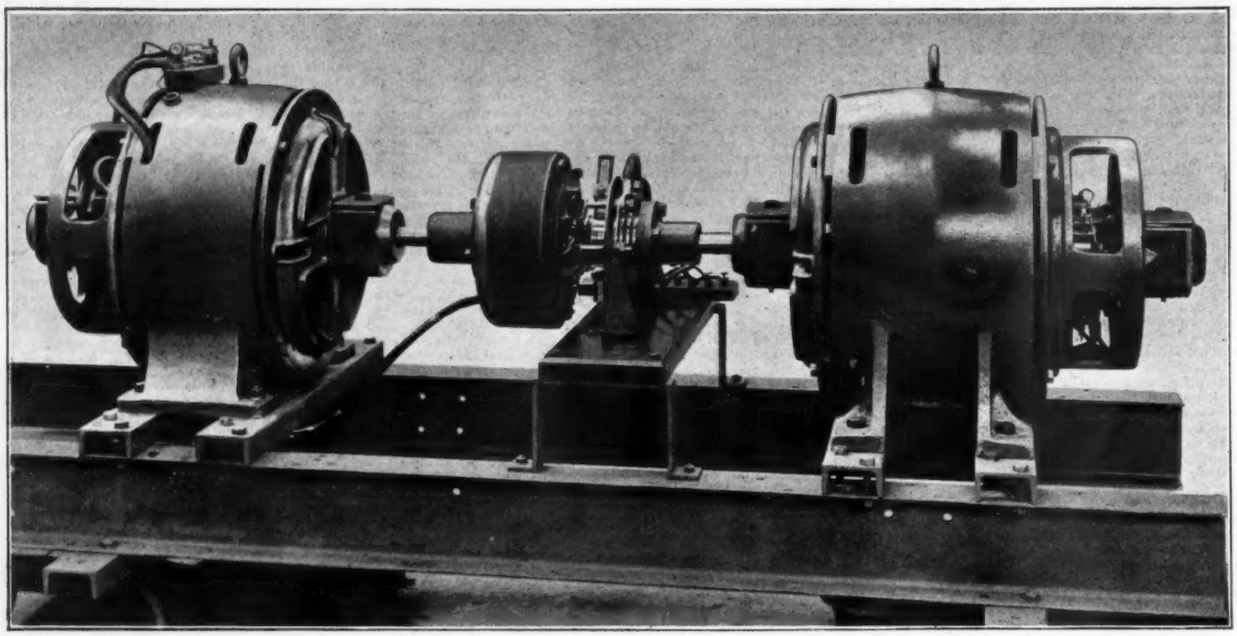
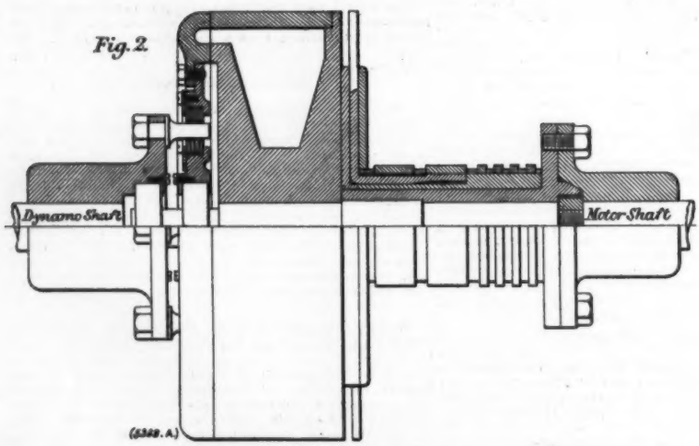


FIG. 1.



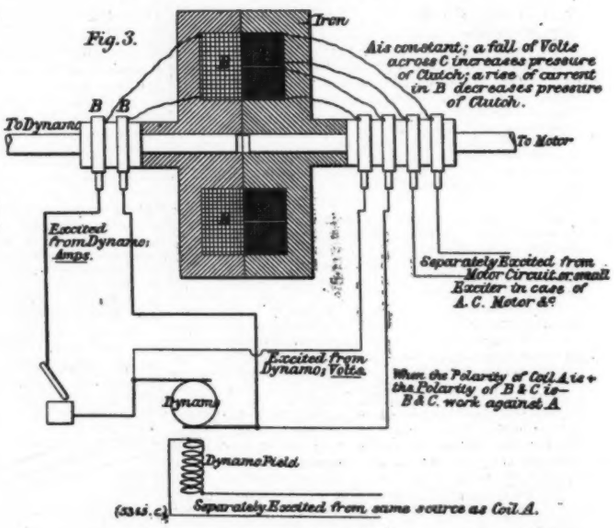
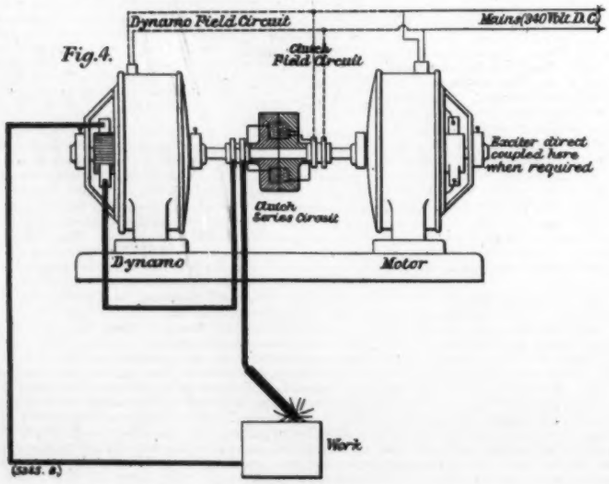
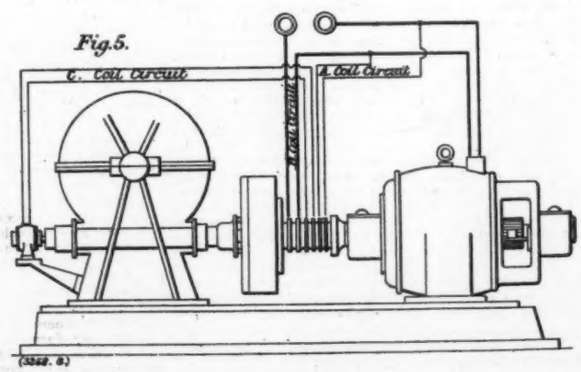


Fig. 3.
Iron
A is constant; a fall of Volts across C increases pressure of Clutch; a rise of current in B decreases pressure of Clutch.
B B
To Dynamo
To Motor
Excited from Dynamo; Amps.
Separately Excited from Motor Circuit or small Exciter in case of A.C. Motor &c
Excited from Dynamo; Volts.
When the Polarity of Coil A is + the Polarity of B & C is— B & C. work against A.
Dynamo
Dynamo Field
(5345. C.)
Separately Excited from same source as Coil A.





MAGNETIC CLUTCH.

A MAGNETIC clutch is, in theory, a wonderfully convenient device. It can be put in and out of action from a distance without shock or noise, and involves no end thrust on the bearings. In practice it is not quite so simple as it would appear at the first glance, due to the residual magnetism which tends to keep up the engagement after the current is cut off. This is by no means an insuperable objection, since the effect of the residual magnetism can be greatly reduced by interposing a non-magnetic substance between the driving and driven members, and aiding it, if necessary by a spring which forces the frictional surfaces apart, and thus lengthens the gap. Naturally a magnetic circuit with a wide gap requires more current to energise it than does one which consists solely of iron, and in that respect is less efficient.

To avoid the difficulties of the ordinary clutch, Messrs. Walter L. Davies and Alfred Sosmes have devised the clutch illustrated on the preceding page, and are exhibiting it at Faraday House, 66, Southampton-row, Holborn, London. Fig. 1 shows it arranged between a motor and a dynamo; Fig. 2 is a section of the clutch before the coils are put in place; Fig. 3 is a diagrammatic view of the windings and connections; Fig. 4 shows the clutch used for electric welding; and Fig. 5 the clutch driving a worm gear. Referring first to Fig. 2, which shows a section of the clutch before the coils are wound, it will be seen that the main part is coupled to the driving shaft, while the armature or keeper is carried on a disc which is free, so that it can apply itself exactly to the magnet. It transmits rotation by four driving pins, carried on a disc on the driven shaft. If the clutch be wound with one coil the current is taken from an arrangement resembling a potentiometer arranged as a circle. Two sliding brushes collect the current. In one position they give the full volts; as they are moved the potential difference and the current drop until they become zero. With further motion the current is gradually increased in the opposite direction until the energisation completely annuls the residual magnetism, and the engagement is broken. The clutch begins to slip, and the pressure is reduced until no further motion is transmitted. The hold of the clutch and its action can therefore be completely and delicately adjusted by means of a simple controller.

If the clutch is to be automatic in its action it requires more than one coil, as shown diagrammatically in Fig. 4. Here two coils oppose each other, the first energising the magnet and the second de-energising it, and when relatively the more powerful, annulling the residual magnetism. The first coil is connected to the motor circuit or to a small exciter, while the second receives a current which is determined by the conditions of work.

There are cases in which it is desired to transmit a constant torque, as, for instance, when a dynamo must give a uniform output through a very variable resistance, as in the case of electric welding by the arc process. The resistance of the arc varies enormously according to the condition of the work, and an actual short circuit may be made. It is for this reason that a constant resistance is usually placed in series with the arc to minimise the fluctuations of the current. To meet such conditions the action of the clutch is as follows: The coil A (Fig. 3) is energised either from the mains or from a small exciter on the driving shaft, and produces an initial pressure of the clutch members which is more than sufficient to transmit the load. Coil B is connected in series with the dynamo armature, and its polarity is such as to counteract the pressure produced by the coil A.

It will be seen that as the current in coil B increases, *i.e.*, as the load is increased, the pressure of the clutch members decreases, until a point is reached when the pressure on the clutch is only just sufficient to transmit the load without slipping. Past this point the clutch slips; it is apparent therefore that the current taken from the dynamo cannot pass a given maximum, even if it is short-circuited, the particular maximum to be reached can be adjusted by adjusting the excitation of the coil A with a rheostat (not shown).

It should be remembered that in the case of a separately-excited dynamo, the torque required to drive it at any speed is proportional to the current taken from the dynamo, irrespective of the speed and volts. If a constant current is taken, it requires a constant torque to drive it at any speed in a fixed field.

To counteract this variation in the coefficient of friction, coil C (Fig. 3) has been added. This coil is connected across the brushes of the dynamo, and its polarity is also opposite to that of coil A.

The effect of these three coils is as follows:—

On open circuit the coil A gives an initial pressure, the coil C, which is across the dynamo brushes, reduces the pressure produced by A. If current is now taken, the coil B still further reduces the pressure until a point is reached when the clutch slips. But when the clutch slips the volts of the dynamo decrease; this decreases the effect of C, which is equivalent to increasing the effect of A, and by this means the slip is prevented from unduly increasing. Should the current taken from the dynamo attempt to increase, the action of the series coil B would decrease the pressure. As a result the coils B and C adjust the pressure so that the current remains practically constant. Since the dynamo is separately excited, its field remains constant, and (owing to the clutch) the armature field is practically constant at all speeds, therefore there is no sparking at any speed, and the dynamo can be instantly short-circuited from open circuit without any harmful result.

Suppose the screw and worm wheel (Fig. 5) to be operating a winding drum, hauling an irregular load, as the load increases the current taken by the motor and flowing through the B coil increases, therefore the pressure of the clutch decreases, until the motor is taking the full current allowed. If the load continues to increase the clutch will slip, but directly it commences to slip, owing to the rapid fall of the coefficient of friction, it would slip down suddenly to a point at a much slower speed, and it would not pick up its normal load again from this point. The load would have to be reduced until the slip of the clutch was sufficiently reduced to reach the ascending portion of the coefficient of friction curve. To obviate this a very small dynamo is attached in any convenient position to the variable speed side of the clutch so that its volts will vary with the speed. This dynamo energises the C coil, and compensates for the variations of friction.

The clutch is obviously suitable for driving any class of machinery subject to sudden shocks, or to very intermittent loading, such as rolling mills, stamping presses, heavy lathes and planing machines, shears, &c. It gives complete protection to machinery likely to be jammed, such as anchor winches, capstans and winding drums, for hauling trucks in mines.

The clutch also acts as an efficient acceleration controller in starting up heavy machinery in which there is a large amount of stored-up momentum, such as hydro-extractors. The clutch is set to slip at full load current or any excess current load suitable to the motor. The motor can then be started up at any speed without accelerating the load sufficiently to overload the motor, and when necessary, the speed-volt curve of the exciter energising the C coil can be arranged to give different degrees of acceleration.

The combination shown in Fig. 1 can be seen by arrangement at Faraday House. Various switches permit several different loads being inserted in the circuit of the dynamo, while an ammeter and a voltmeter demonstrate how nearly the desired result is attained. The results are wonderfully exact, the current setting down with extreme rapidity to its desired amount. For many purposes the clutch should prove of great value. It is, perhaps, advisable to point out that the slipping clutch has not to absorb the difference between the maximum and the minimum power required. The power absorbed by the friction of slipping is only a fraction of the difference experienced by the motor.

THE NORWEGIAN SUPERPHOSPHATE INDUSTRY.—The new superphosphate company of Knarvik, which commenced operations this last summer, has already found it necessary to increase the capital from 3,000,000 kroner to 5,800,000 kroner. Some 8,000 tons of superphosphates have already been produced, the working of the apatite deposits is about to be undertaken and a copper extraction factory is in course of construction.

SMALL ELECTROMAGNET FOR MEDICAL MEN.—In order to facilitate the work of the surgeon who wishes to pick out small particles of iron from the human body, Professor G. Sultan has devised a handy small electromagnet. The magnet is held by a fork which is pivoted on a small stand and can thus be swung round and inclined at will; the magnet can further be shifted in its fork by means of a hand wheel, so that the conical pole piece can be adjusted to any particular spot. The instrument is illustrated in the *Elektrotechnische Zeitschrift* of October 8, 1917.

LARGE NEW GERMAN COMPANY FOR UNDERTAKINGS OVER SEAS.—In Hamburg a large financial, commercial and industrial company is in course of formation for the promotion of German enterprise and German interests over seas. The capital, in the first instance, is to be 20,000,000 marks; large industrial companies, shipping concerns, export firms and Banks are interested in the new venture, not only in Hamburg, but in the whole of the German Empire. The new company will work for the furtherance of German oversea business in all directions; it embodies the twofold work of being an investigating syndicate, and a financing institute. Special attention will be paid to large international undertakings, such as water works, harbour and railway construction, &c., which are to be both planned and financed.

THE IRON ORE DEPOSITS OF RUSSIA.

RUSSIA is rich in iron ore as in numerous other minerals, and although its iron industry has not kept pace with that of other countries it has made great strides, and now holds the fifth place in the world, with a production of 4,565,000 tons of pig-iron in the last year before the war, 1913. After some not very successful attempts had been made in the south of Russia, an Englishman, Mr. John Hughes, started the first iron works and rolling mills. He received Government aid in various ways on condition of his producing 24,000 tons of rails per annum. Two more iron works were started, likewise based on the iron ore deposits of the Donetz district; but as these deposits were irregular and the percentage of iron not satisfactory, no real headway was made. About the eighties, however, iron ore deposits were discovered at Krivoirog, on the border between the governments of Ekaterinoslov and Kherson, along the river Ingulez, over a distance of about 100 km.. These ores are very rich in iron, generally containing 60–70 per cent.—at times more. Ore containing less than 55 per cent. is looked upon as poor, and is only used in exceptional cases. In the northern portion of the Krivoirog basin the ore deposits are more diffused; the beds are in places some 2,000 ft. long, with a thickness of as much as 300 ft. In the southern portion of the basin the strata are generally separated by other materials, while their thickness is considerably less, as a rule only from 15–20 ft. In the northern portion the working generally takes place in the open, whilst in the southern it is mostly confined to regular underground mining, a depth of 900 ft. having been reached in the year 1913. A Government commission examined the deposits in the year 1909, and estimated their capacity at about 200,000,000 tons. Since then, however, several new deposits have been discovered, and the actual capacity no doubt materially exceeds the above figure.

The exploitation of the Krivoirog deposits, as far as the southern portion is concerned, commenced as early as 1871, but some twenty years passed before the working of the northern section was taken in hand. To begin with the production was not on a very large scale, only amounting to some 500,000 tons in the year 1892. The construction, however, of the railway connecting Krivoirog with the Donetz basin materially increased the output, as will be seen from the appended figures:

	Tons.
1901	1,800,000
1911	4,650,000
1913	6,250,000

The Krivoirog deposits have for the last 20 years held the leading place as regards the production of iron ore in Russia, and account, at present, for 72 per cent. of the total.

Most of the iron ore produced in the Krivoirog district, say some 80–90 per cent., is used by the South Russian and a smaller portion by the Polish and Central Russian metallurgical undertakings, which to a great extent themselves control many of the iron ore deposits, and it is not unusual for some of these works to produce more iron ore than they themselves require. This surplus is exported to Great Britain, Holland, Germany, &c., the quantities varying considerably both amongst the different countries and for the different years, the aggregate export for the last four peace years being as under:

	Tons.
1910	834,090
1911	872,390
1912	653,010
1913	462,500

During 1913 Germany, either directly or through Holland, received 87 per cent. of the exported iron ore.

Iron ore deposits are also found on the peninsula of Kertsch, generally in layers of as much as 35 ft. thickness, the ore being somewhat oily and always containing manganese and phosphorus, the respective percentages of the various substances generally amount to:

	Per Cent.
Iron	35 to 40
Manganese	5 „ 7
Phosphorus	½ „ 2½

On mining the ore only about 20 per cent. is obtained in pieces, the rest coming out as dust, which can only be used for smelting after having been briquetted or mixed with about one-third of Krivoirog ore.

According to an investigation and calculation undertaken by Professor Bogdanovitsch, Director of the Geological Committee, the Kertsch peninsula contains some 500,000,000 tons of ore. As late as 1914 there were only two concerns working in these districts, the Russian Providence Company and the Taganrog Metallurgical Company, which jointly produced in 1913, 472,600 tons, and in 1914, 540,400 tons. The ore is worked from open drifts and partly by means of excavators; the deposits are situated near the coast, and most of the ore is transported by water, across the Azoff Sea to the two works mentioned above at Maiopol and Taganrog, only a small portion being despatched by rail.

Compared with the deposits of Krivoirog and Kertsch those of the Donetz basin are of less importance, with a decreasing production, the output having receded from 137,000 tons in 1903 to 4,500 in 1913.

To complete the account it should be mentioned that in the Korsak Mogila district, in the Government of Tacoria, there are deposits of magnetic iron ore and red hematite of good quality, containing 66 to 67 per cent. of iron, of which some 3,000 tons have been worked annually during the last few years.

The Ural is rich in iron ore deposits, which especially

are found in the governments of Orenburg and Perm, from Verchneuralsk in the south to Verchoturje and Tscherdinsk in northern Ural, the deposits already known and investigated being calculated to contain at least 270,000,000 tons. These ores vary very materially and the proportion of iron ranges between 42 and 66 per cent. There are both magnetic iron ore, red hematite, brown hematite and sparry iron ore. To the south-west of Verchoturje, in the mountains of Vysokaja and Bergodat there are some of the richest deposits of magnetic iron ore, and they yield about one-fourth of the total production in the Ural. The old estates, with mines and forests in the Ural, formerly belonged mostly to noble Russian families, but of late years, when it had become manifest that a remunerative and national exploitation of the mineral wealth of the country would only be brought about through large industrial concerns with plenty of money at their back, several limited companies were formed, aided by some of the leading banks. As examples of this new departure there may be mentioned the three companies Schuwalov, Bogoslov and Nikolai-Pavdinsk, with capitals ranging from 15,000,000 to 25,000,000 roubles and each owning vast territories of about 3,000 sq. miles. (Rouble = 2*s.* 1*d.*)

In the Ural 27 large and several smaller iron works are in operation, and their production amounted in the aggregate to 1,420,000 tons iron in 1913, and 1,470,000 tons of iron in 1914. Whilst in southern Russia anthracite and coke are used in the iron industry, charcoal is used in the Ural, and the quality of the iron produced is correspondingly good. The extensive use of charcoal has commenced to tell upon the forests, and the further important development which the Ural industry no doubt will experience when political matters have settled down will make the obtainment of fuel from other sources a necessity. This demand will not be difficult to supply, all that is needed being the construction of some new railways, both to the coal fields within Ural and to those in the neighbouring western Siberia.

As far as the Polish iron ore deposits are concerned, they are principally found in the four southern governments, those of Kalisch, Petrokov, Radour and Kielce, and those which so far have been worked and examined are estimated to have a capacity of some 300,000,000 tons, which should be equal to about 120,000,000 tons of pig-iron. The Polish iron ore is not all of the same quality; the richest deposits are those of the Government of Petrokov, where the ore comes out in solid pieces and contains an average of 32 per cent. of iron. Next in importance come the deposits in the Government of Radom, where the iron ore partly consists of brown hematite, with a percentage of iron ranging between 35 to 45, but it is harder to smelt. In the Government of Kielce only red hematite is found. The iron production in Poland, although of ancient origin, stagnated until the building of the first railway in the year 1885, the line Ivangorod—Dombrow, which gave a great impetus to Polish industry generally. The production reached its highest point in the year 1900, when it amounted to 475,000 tons, but at that time the Polish iron works began to use the Krivoirog ore, and as this contained more iron, it tended to reduce the production of native iron ore, so that out of a consumption in the year 1913 of 585,000 tons, less than half was Polish, the larger portion hailing from Krivoirog, where some of the Polish iron works have acquired iron ore deposits.

The iron industry in Central Russia dates from the seventeenth century, but owing to the less satisfactory iron ore deposits in that part of the country, it only made slow progress, reaching its maximum of an annual production of 240,000 tons of pig iron in 1899; it then fell off considerably, but again rallied, and the output of pig-iron amounted to 200,000 tons in 1913. Some of the iron works in that part, like the Polish, draw part of their supply of ore from the Krivoirog deposits. The more important iron ore deposits in Central Russia are located in the Governments of Moscow, Trier, Smolensk, Kaluga, Orel, Tula, Rjasan, Vladimir, Nijni-Novgorod and Kasan. The ore mostly consists of brown hematite, containing from 26 to 52 per cent. of iron, often with phosphorus intermixed. The fact of the Central Russian coal not being suited for coke production and that the forests of the district have been severely taxed also tends to depress the Central Russian iron industry.

Some unimportant iron ore deposits are found in northern Russia, in the Governments of Obonetz and Wologda, whilst rich and extensive deposits are situated in Caucasus, which, however, with a few exceptions, have the not yet been properly exploited. In the Bartochalinsk district in the Government of Tiflis, there are iron ore deposits containing spiegel iron and magnetic ore with an iron percentage of 50 per cent., and in the Government of Elisabetpol ore with 60 per cent. of iron, but neither has so far been exploited. Some iron ochre deposits in the Government of Kutais are being exploited to obtain ochre, of which the production in 1913 amounted to 350,000 and in 1914 to 525,000 kilograms.

Iron ore deposits are also to be found in Turkestan, but owing to their inaccessible location and the absence of railway communications they have not been worked so far. The same applies to the many rich iron ore deposits in western and eastern Siberia. Some of these, however, are likely to be exploited ere long; this, for instance, applies to the magnetic iron ore deposits, at Talbes in the Altai district, and the deposits in the Ussuri district in eastern Siberia, near the St. Olga bay. The former belonged to the Imperial domain and have been rented to the Kusnetz Coal Mining Company, and work preparatory to commencing a national exploitation has been going on for some little time.

There are also rich deposits of magnetic iron ore in the Government of Irkutsk along the river Oka, along which the iron ore, which contains from 40 to 55 per cent. iron is conveyed to the Nikolajewski Savod iron works. Further deposits containing ore with so much as 65 per cent. of iron, are situated at the river Aabakan, an important auxiliary of the Jenitsei, where is situated the Abakanski Savod iron works. In the year 1908 a complete stoppage of the Siberian iron industry occurred, and it is now of but very slight importance.

As to the uses to which the Russian production of pig-iron is put, and the material fluctuations which have taken place in this connection, the subjoined table supplies some information.

—	Weldable iron	Bessemer.	Steel.	
			Martin.	Crucible.
	tons.	tons.	tons.	tons.
1884 ..	572,000	118,000	79,000	3,000
1894 ..	610,000	201,000	782,000	5,000
1904 ..	250,000	656,000	2,056,000	8,000
1909 ..	119,000	571,000	2,300,000	5,000
1913 ..	48,000	782,000	4,005,000	6,000
1914 ..	34,000	832,000	3,870,000	8,000

The distribution between the different districts of the Russian manufacture of iron will appear from the following table:—

—	Southern Russia.	Ural.	Poland.	Central Russia.	Northern Russia.
	tons.	tons.	tons.	tons.	tons.
Weldable iron	—	19,000	5,000	1,000	9,000
Bessemer steel	785,000	47,000	—	—	—
Martin steel ..	1,979,000	847,000	343,000	443,000	258,000
Crucible steel	—	5,000	—	—	3,000

The above figures apply to the year 1914. It will also be noticed that in Russia, as elsewhere, the Martin process has advanced at the expense of the Bessemer process. In the year 1914 there were in operation in Russia 23 Bessemer converters, 11 Thomas, 264 Martin furnaces, 148 puddling furnaces, &c.

Parallel with the development of the Russian iron and steel industry runs a corresponding increase in the production of finished iron and steel goods, the growth from 1903 to 1914 amounting to 60 per cent. The following table shows the quantities of finished iron and steel products for the years 1910, 1913 and 1914.

—	1910.	1913.	1914.
	tons.	tons.	tons.
Southern Russia ..	1,595,000	2,274,000	2,321,000
Ural	597,000	658,000	655,000
Poland	331,000	437,000	279,000
Central Russia ..	279,000	342,000	355,000
Northern Russia ..	169,000	264,000	255,000

The production, as percentage of the entire production of the country, of the different parts of the country, comes out as under:

	Per Cent.
Southern Russia about	60
Ural about	17
Poland about	7
Central Russia about	9
Northern Russia about	7

The finished products can be divided into the following classes:

—	1913.	1914.
	tons.	tons.
H iron	277,000	256,000
Rails	578,000	644,000
Bar iron	1,378,000	1,236,000
Rolled wire	294,000	232,000
Iron and steel plates:		
" " " thick	447,000	503,000
" " " thin	408,000	385,000
Hoop iron	82,000	103,000
Other sorts	511,000	506,000
Total	3,975,000	3,865,000

The following remarks may be of interest:

H Iron.—The rolling of this section has from 1910 to 1913 been doubled; about 94 per cent. is produced in southern Russia, the balance in Ural, Poland and northern Russia.

Rails.—The principal centre of manufacture is southern Russia, with about 79 per cent., the balance being produced in the Ural.

Bar Iron.—More than half of this commodity is manufactured in southern Russia, the rest being divided between the other districts.

Rolled Wire.—Southern Russia accounts for about 57 per cent., Poland, northern Russia and Ural coming next.

Iron and Steel Plates.—The south Russian works produce about 75 per cent. of the total.

Iron and Steel Plates, Thin.—The Ural works supply about 60 per cent., whilst the works in southern Russia although they have only recently taken up this manufacture, already account for 25 per cent.

Hoop Iron.—This production belongs to southern Russia and Poland.

Manganese ore is found in Russia in larger quantities than in any other country. The appended table shows the world's export of manganese ore for four different years:—

Exported from.	1900.	1909.	1911.	1912.
	tons.	tons.	tons.	tons.
Caucasus ..	425,000	524,000	575,000	822,000
Southern Russia	—	42,000	14,000	31,000
India	90,000	520,000	656,000	647,000
Brazil	130,000	243,000	211,000	140,000
Other countries (Spain, Germany, France, &c.)	287,000	12,000	29,000	35,000
Total ..	932,000	1,341,000	1,485,000	1,675,000

The principal importers were Great Britain, United States and Germany, England and Holland imported the largest quantities of Russian manganese ore, but the exports to Holland were really intended for Germany, being despatched by waterway after the discharge in Dutch ports, so that Germany receives more than one-third of the Russian exports of manganese ore.

Manganese ore is worked in three different districts of the European Russia, the Caucasus being at the head of the list; the deposits there are in the Tschiaturi district in the Government of Kutais, next at Nikopol in the Government of Ekaterinoslov and finally in the Ural in the Governments of Perm and Ovenburg.

Of these the Tschiaturi deposits are the richest; the entire output is exported, and forms about 95 per cent. of the aggregate Russian export of manganese ore. The Tschiaturi ore is sent by rail to the ports of Pola and Batum, a distance of respectively 160 and 200 kilometres. The manganese ore production in southern Russia amounted in 1913 to about 270,000 tons, of which 55,000 tons were exported, whilst the rest was used by the metallurgic works of southern Russia. The production in the Ural, which is used for local consumption, is insignificant, amounting in 1913 to about 7,000 tons. The Russian manganese ore contains about 55 per cent. of manganese.

We are indebted for the above particulars to a report to the Danish Foreign Ministry.

PRICE OF IRONSTONE IN THE MIDLANDS DISTRICT.—The Minister of Munitions has ordered as follows: (1) On and after the 17th inst. no person shall, until further notice, buy, sell, deliver or deal in, or offer to buy, sell, deliver or deal in any ironstone mined, or to be mined, in the districts of Rutlandshire, Leicestershire, Northamptonshire north-east of a straight line drawn from Rugby to Buckingham, Lincolnshire south of a straight line drawn from Newark to Sleaford. The maximum price for ironstone per ton f.o.t. at mine or quarry is 3*s.* 9*d.*, and for every sum of 1*s.* 3*d.* per week by which the rate of wages for ironstone getters employed at any particular mine or quarry in the districts specified is increased above the rate current at such mine or quarry on November 12, 1917, there may be added to the above-mentioned maximum price for ironstone mined the sum of ½*d.* per ton. This Order may be cited as the "Midlands District Ironstone Control Order, 1918."

THE ILLUMINATING ENGINEERING SOCIETY.—Mr. L. Gaster, the honorary secretary of the Illuminating Engineering Society, addressed the society on January 15 on "Ten Years of Illuminating Engineering, its Lessons and Future Prospects." Reviewing the work done, he dwelt on the relations with other bodies and on further methods of co-operation with them, and especially also on relations to the State in connection with future reconstruction problems. In order to strengthen their plea for good lighting, he had drawn up inquiry sheets to facilitate the collection of data on accidents in the streets and in works. The questions put do not include inquiry about individual compensation, but suggest that information as to total compensation paid during a given period for accidents of particular classes might be given. Quotations from publications like "The Health of the Munition Worker" support his case.

COMBINATION OF SPRINKLER AND HEATING SYSTEMS.—The use of automatic sprinklers for the extinction of fires has so much spread that the utilisation of the sprinkler pipes for heating the buildings, which has successfully been introduced in America, appears to be of general interest. The fundamental objection is, of course, that the sprinkler head, upon the melting of which the safety device depends, would, in the ordinary run, melt at the temperatures wanted for the water that is to heat the building. By introducing a U-connection for the head, through which the hot water cannot circulate, this objection is said to have been overcome. According to an article by E. D. Densmore, in the quarterly of the American National Fire Protection Association, October, 1917, a bend in the horizontal nipple, carrying at its end the upright sprinkler head, will prevent the head from melting, and the required connections of the hot-water system with the sprinkler piping are of a simple kind. From the heater a hot-water pipe is taken over to the foot of the sprinkler riser inside the sprinkler alarm valve; an ordinary stop-valve is provided at this point to cut off the water-supply, if necessary. No fundamental difficulties are said to have arisen in the many installations that have already been in operation for several years.

"ENGINEERING" ILLUSTRATED PATENT RECORD.

SELECTED ABSTRACTS OF RECENT PUBLISHED SPECIFICATIONS UNDER THE ACT OF 1907.

The number of views given in the Specification Drawings is stated in each case; where none is mentioned the Specification is not illustrated.

Where inventions are communicated from abroad, the Names, &c., of the Communicators are given in italics.

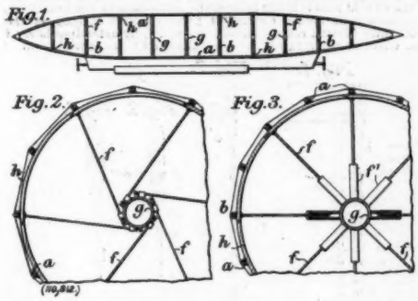
Copies of Specifications may be obtained at the Patent Office, Sales Branch, 25, Southampton Buildings, Chancery-lane, W.C., at the uniform price of 6d.

The date of the advertisement of the acceptance of a Complete Specification is, in each case, given after the abstract, unless the Patent has been sealed, when the word "Sealed" is appended.

Any person may, at any time within two months from the date of the advertisement of the acceptance of a Complete Specification, give notice at the Patent Office of opposition to the grant of a Patent on any grounds mentioned in the Act.

AERONAUTICS.

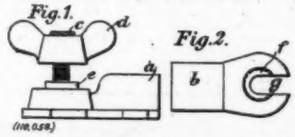
110,812. A. M. Low, Feltham, J. Dickinson, London, and British Aircraft, Limited, London. Framework of Airships. (6 *Figs.*) November 18, 1916.—This invention relates to the framework structure of airships more particularly of the rigid aerostat class and of that type which include transverse frames comprising elements capable of automatic expansible and contractible movements in accordance with the expansion and contraction of the gas contained within the aerostat, as by making said transverse frame of relatively slidable or telescopic



elements. According to the invention, each transverse frame member *b* comprises, in combination, a central hub *g*, a plurality of relatively movable peripheral sections *h* carrying longitudinal frame elements *a*, a plurality of radial elements *f* connecting said hub *g* and peripheral sections *h*, either in sliding relation to the central hub *g* by passing through sleeves or bosses attached to the hub, or as shown in Fig. 3, each of said radiating elements is formed of a plurality of telescopic or relatively slidable parts or sections *f*, *f*1. (*Accepted November* 14, 1917.)

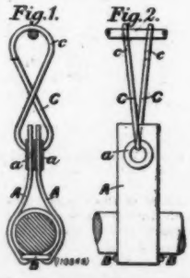
ELECTRICAL APPARATUS.

110,858. The Chloride Electrical Storage Company, Limited, and H. Dean, Clifton Junction, near Manchester. Electric Cable Connectors. (6 *Figs.*) February 27, 1917.—This invention relates to means for detachably securing together the ends of electric cables. The invention comprises the arrangement of one part of the connector with a screwed stud *c* having



a nut *d* thereon, and a boss-like projection *e* at the base of said stud, and the arrangement of the other part with a slotted end *g* and a recess *f* around the closed end of the slot corresponding in shape with the boss-like projection *e* with which it co-acts, the nut *d* serving to secure the two parts together. (*Accepted* November 14, 1917.)

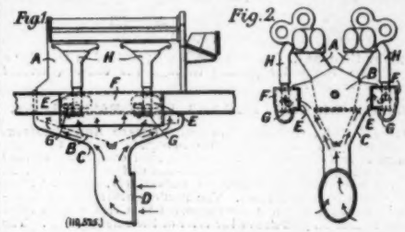
110,848. W. T. Henley's Telegraph Works Company, Limited, London, and R. Povey, Manchester. Electric Cable Suspenders. (7 *Figs.*) January 20, 1917.—This invention relates to suspenders for electric cables spaced along the length of the cable according to local requirements and without being permanently attached to the cable, of the kind comprising a flexible band which is adapted to be looped around the cable and attached to an independent carrier wire by a



hooklike wire device, so that the cable may be rapidly suspended or removed as desired, and provided with a ring or eye attached to the dependent end of the band adapted to engage and slide over the latter so as to permit of the band, when looped about the cable, becoming tightened thereupon under the weight of the cable. According to this invention, the link or eye B is not attached to either end of the band A but is freely slidable upon both end portions thereof, and both ends of the band A are eyeletted at *a* for engagement with a suspension hook C. Hence, when the band has been placed over the cable with its ends dependent therefrom, the link or eye may be passed over both ends and moved upwards until the bight formed at the middle portion of the band is drawn tightly down upon and around the cable, after which the ends of the band may be folded upwards at either side of the cable (thereby ensuring the bight formed round the cable securely gripping same), the two ends being secured together by means of the suspension hook C which is hooked over the carrier wire or other support. Owing to the improved construction, the weight of the cable will always ensure the bight of the band being drawn so tightly about the cable by the weight of the latter as to cause the cable to be securely gripped and prevent the suspenders from creeping no matter how small its diameter; while the distance between the suspension wire and cable is very small. (*Accepted November* 14, 1917.)

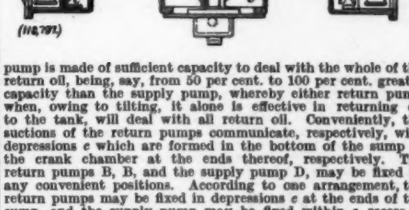
GAS ENGINES, PRODUCERS, HOLDERS, &c.

110,875. Sunbeam Motor Car Company, Limited, and L. Coatalen, Wolverhampton. Internal-Combustion Engines. (2 *Figs.*) October 23, 1916.—This invention relates to internal-combustion engines, and has for its object to provide means for cooling the crank chamber, warming the carburettors and the air which is carburetted, and for supplying the carburettor with air at the required pressure. The engine comprises a pair of cylinder blocks A set at a small angle upon a crank chamber B enclosed in a casing C, which forms a jacket, and is provided with an aperture D, which preferably projects in the



direction of motion. This casing is closed at the top except for apertures at E, which communicate with compartments F built round the carburettors G, which communicate with the engines by means of the induction pipes H. The carburettors are completely enclosed so that the only air passing to the induction pipes H is that which enters at D and travels over the surface of the crank-case, cooling this and warming the air. By arranging the inlet D at the front the air is supplied under slight pressure due to the motion of the engine through the air. (*Accepted November* 7, 1917.)

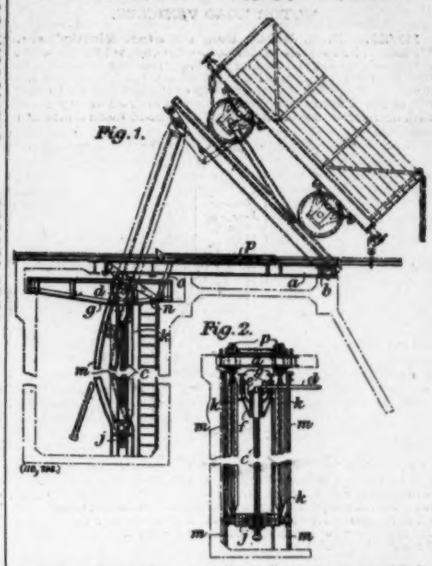
110,797. Wolseley Motors, Limited, and A. A. Remington, Birmingham. Internal-Combustion Engines. (3 *Figs.*) November 2, 1916.—This invention relates to internal-combustion engines which are liable to be considerably tilted. According to this invention, two pumps B, B, are employed for returning the oil from the sump C of the crank chamber to the tank, and the suctions *b* of these pumps communicate, respectively, with the bottom of the sump at points thereof which are, respectively, at or near the ends of the sump. So long as the engine remains substantially level fore and aft, both the return pumps will be effective in returning oil to the tank; but, when the engine tilts to an extent to cause the suction of one of the return pumps to be above the level of the oil within the sump, with the result that such pump draws air only, the other return pump will deliver the oil from the sump to the supply tank. Each return



pump is made of sufficient capacity to deal with the whole of the return oil, being, say, from 50 per cent. to 100 per cent. greater capacity than the supply pump, whereby either return pump when, owing to tilting, it alone is effective in returning oil to the tank, will deal with all return oil. Conveniently, the suctions of the return pumps communicate, respectively, with depressions *c* which are formed in the bottom of the sump of the crank chamber at the ends thereof, respectively. The return pumps B, B, and the supply pump D, may be fixed in any convenient positions. According to one arrangement, the return pumps may be fixed in depressions *c* at the ends of the sump, and the supply pump may be fixed within a recess *c*1 formed in the bottom of the middle of the sump, and the three pumps may be driven by a common shaft G. (*Accepted November* 14, 1917.)

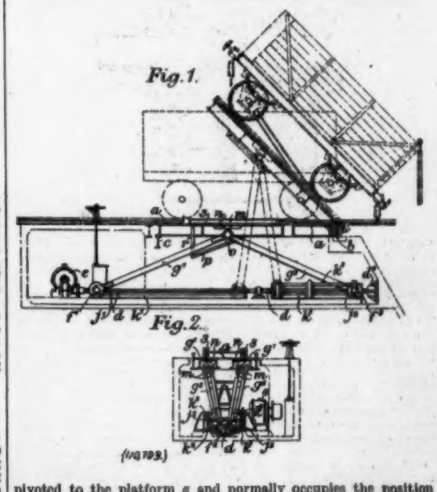
MINING, METALLURGY AND METAL-WORKING.

110,708. Simon-Carves, Limited, and W. Gracie, Manchester. Apparatus for Tipping Wagons. (2 *Figs.*) May 17, 1917.—This invention relates to apparatus for tipping wagons and has reference to apparatus comprising a tipping platform whereon the wagon is run and which is raised to tip the wagon and lowered by screw-and-nut mechanism. *a* is the platform hinged at *b*, and whereon the wagon is run. Below the free end of the platform *a* is arranged a screwed rod *c* adapted to be rotated by a shaft *d* and bevel gearing *e*. The rod *c* is mounted in a bearing *f* depending from girders *g*, to which it is pivoted in line with the shaft *d*. On the screwed rod *c* is mounted a travelling nutlike crosshead *j*, to which are pivoted links *k*. The pivots are fitted with flanged rollers which operate in guides *m* and prevent lateral movement of the crosshead *j* and rod *c*. The upper ends of the links *k* are pivoted to levers *n* pivoted to the platform *a*. The other ends of the levers *n* are pivoted to links *o*, which are also pivoted to the limbs of a sprag *p* arranged between the rails on the platform *a* and pivoted to the latter. To tip the wagon run on the platform *a*, the screwed rod *c* is rotated in the appropriate direction to travel the crosshead *j* upwardly thereon. As the crosshead travels on the rod *c*, it follows the path defined by the guides and the rod *c* gradually swings about its pivots. During the initial travel of the crosshead the links *k* operate the levers *n* and the levers by means of the links *o* operate the sprag *p* until the free ends of the limbs of the sprag are in the way of the rear axle of the wagon and the levers *n* abut against stops on the underside of the platform *a*. The continued travel of the crosshead *j* raises the platform *a* about its pivot *b* and carries the wagon into the tipping position, as shown in



dot-and-dash lines in Fig. 1, the wagon being retained on the platform *a* by the sprag *p*. During lowering, the operations are reversed; that is to say, the platform is first lowered into the normal position and the sprag *p* is then withdrawn to its normal position. (*Accepted November* 7, 1917.)

110,709. Simon-Carves, Limited, and W. Gracie, Manchester. Apparatus for Tipping Wagons. (2 *Figs.*) May 17, 1917.—This invention relates to apparatus for tipping wagons, and has reference to apparatus comprising a tipping platform whereon the wagon is run, and which is raised to tip the wagon and lowered by screw-and-nut mechanism. *a* is the tipping platform on which the wagon to be tipped (indicated in dotted lines) is run, and pivoted at one end at *b* and normally supported at the other end on a girder *c*. Below the platform *a* is mounted a screwed shaft *d* adapted to be rotated by an electric motor *e* through gearing, and having oppositely screw-threaded portions on which nutlike crossheads *f*1, *f*2, are mounted and travel on rotation of the shaft. Links *g*1, *g*2, are pivoted to the crossheads *f*1, *f*2, and have their upper ends connected together toggle-fashion. The pivots of the lower ends of the links *g*1, *g*2, carry rollers *j*1, *j*2. The rollers *j*1 run on a track *k*1 and the rollers *j*2 run on a lower track *k*2 and below an upper track *k*3. The pivots of the toggles carry rollers *m* adapted to bear against tracks *n* thereon. The pivots of the toggles carry arms *o* pivoted to levers *p* which are pivoted to the platform *a* and to links *r*, the other ends of the links *r* being pivoted to a sprag *s* which is

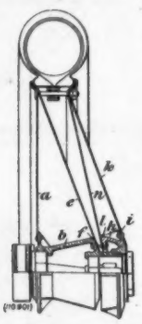


pivoted to the platform *a* and normally occupies the position shown in full lines. On the shaft *d* being rotated in one direction, the crossheads *f*1, *f*2, approach each other and the links *g*1, *g*2, are caused to approach the vertical. During the initial travel of the crossheads *f*1, *f*2, and movement of the links *g*1, *g*2, the arms *o* operate the levers *p* and the links *r* until the free ends of the sprag *s* are moved into the way of the rear axle of the wagon and the rollers *m* bear against the tracks *n* on the underside of the platform *a*. The continued travel of the crossheads *f*1, *f*2, and movement of the links *g*1, *g*2, raise the platform *a* on its pivot *b* to tip the wagon, as shown in dot-and-dash lines in Fig. 1. As the crossheads *f*1, *f*2, are arranged to travel at different speeds, the knuckles of the toggles do not rise in a straight path, but follow a curved path which is approximately concentric to the pivot *b* of the platform *a*. On the reverse rotation of the shaft *d*, the platform is first lowered to its normal position and the sprag *s* then withdrawn clear of the wagon axle into its normal position. The rollers *j*1, *j*2, running on the tracks *k*1, *k*2, take the downward thrust of the links *g*1, *g*2, and relieve the shaft *d* therefrom. The upward thrust of the links *g*2 when the links *g*1 pass the position in which they are at right angles

to the platform a is taken by the rollers j_2 bearing against their upper track k_2. The end thrusts of the shaft d are taken by the double thrust bearing d^3. (*Accepted November 7, 1917.*)

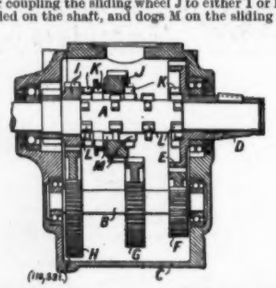
MOTOR ROAD VEHICLES.

110,901. F. E. Baker, King's Norton, Birmingham. Wheels. (2 *Figs.*) March 13, 1917.—The object of the invention is to enable rivets to be used for separately securing both the main disc and the internal or stiffening disc, and for this purpose the invention comprises the construction of the hub or bush so that one of the discs can be secured by rivets inserted at or secured with the interior of the hub or bush. The main disc a is attached



to the hub b by rivets. For the connection of the stiffening disc e, the hub is formed with a shoulder f which is accessible through the interior of the hub for the insertion or securing of the rivets. Likewise the bush h is formed with a flange i to take one set of rivets securing the outer detachable disc k and an internal flange l to receive the rivets for the stiffening disc n. (*Accepted November 14, 1917.*)

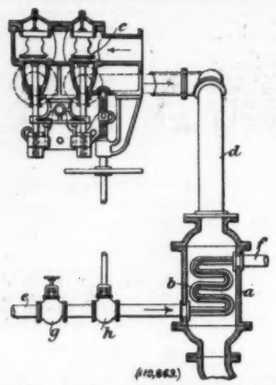
110,581. Triumph Cycle Company, Limited, and G. E. Stanley, Coventry, Warwickshire. Change-Speed Gears. (3 *Figs.*) October 24, 1916.—This invention relates to change-speed gears of the kind in which parallel driving and lay shafts are employed, and a driven shaft is disposed concentrically with the driving shaft and geared permanently to the lay shaft; sliding gear wheels being provided on one of the shafts to co-operate with wheels on the other shaft. According to this invention, the sliding member has dogs on each side to clutch it to the shaft, which dogs engage with splines on the shaft after the sliding toothed wheel is meshed with its appropriate toothed wheel on the lay shaft. A driving shaft A and a lay shaft B are mounted in a gear-box C. A driven sleeve D is loosely mounted on the driving shaft A and carries a toothed wheel E permanently meshed with a wheel F, which is the smallest of three wheels F, G, and H, rigidly mounted on the lay shaft B. A wheel I is loosely mounted on the driving shaft A, and is permanently meshed with the wheel H. A sliding wheel J is adapted to be moved along the shaft A by a forked rod so as (1) to clutch the wheel E to the shaft for direct drive or (2) to mesh the wheel E with wheel G for the second speed, or (3) to clutch the wheel I to the shaft for the low speed. The clutch parts are arranged as follows:—On each side of the wheels I, J and E, dogs K are provided for coupling the sliding wheel J to either I or E. Splines L are provided on the shaft, and dogs M on the sliding wheel can



engage the splines in any one of the speed positions. In order to facilitate the engagement of splines L and dogs M, each ring of splines is composed of alternately long and short elements, and the dogs are similarly arranged, so that when moving into engagement, first the longer projecting splines engage the lower projecting dogs and then the shorter splines and dogs engage. To facilitate gear changing, either from second speed to low or from second speed to high, the parts are so dimensioned that should the long dogs M abut end-on against the splines L, the wheel J will still have a slight engagement with the wheel G, so that it will be revolved at a different speed to the driving shaft, and the long dogs and splines will slip out of end-on contact and will engage properly. The wheel J will then have moved out of engagement with the wheel G, and the wheel J will be running at the same speed as the driving shaft, and as the gear wheel to be engaged (the gear wheel I) is connected with the driven member it is almost certain to be revolving at a different speed so that full engagement of the dogs M with the splines L, and the engagement of the gear wheel dogs K is easily effected. Similarly, in changing from low or high into second speed the wheel J is first engaged with the wheel G. If the dogs then come end-on the different rates of revolution of the driving shaft and of the sliding element will cause the dogs to slide out of end-on contact, when they will immediately engage properly. *Accepted November 7, 1917.*)

SHIPS AND NAUTICAL APPLIANCES, &c.

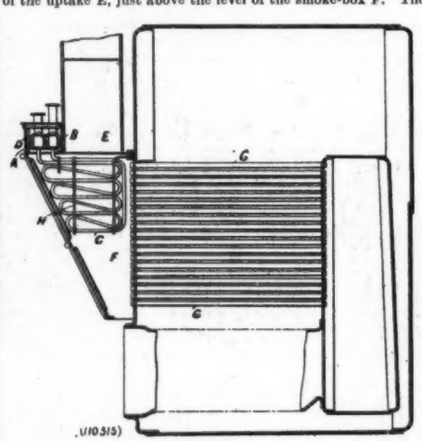
110,863. R. S. Portham, London. Marine Propulsion. (1 *Fig.*) March 6, 1917.—The invention relates to steam turbine installations for marine propulsion. According to the present invention, superheated steam is brought into indirect contact with a cooling medium in its passage from the turbine stop valve to the turbine, whereby the steam is reduced to and maintained at the desired reduced temperature. In carrying out the invention, according to the method illustrated, the cooler or decaloriser a is mounted, preferably, on the casing of the astern turbine (not shown). The decaloriser is of the surface-condensing type and is provided with cooling coils b. Superheated steam is led from the astern turbine stop valve c by way of the pipe d, and through the cooler thence to the inlet of the astern turbine. Cooling water is supplied to the coils by the pipe e, preferably from the circulating circuit of the main condensers, and is led



away by the pipe f. Valves g and h are provided in the pipe e to regulate the water passing through the coils. (*Accepted November 14, 1917.*)

STEAM ENGINES, BOILERS, EVAPORATORS, &c.

110,515. T. Sugden, London. Steam Superheaters. (4 *Figs.*) May 24, 1917.—This invention relates to steam superheaters for marine boilers, of the kind comprising vertical elements arranged within the smoke-box of the boiler. A, B, are the inlet and outlet headers respectively, and C, C, the banks of superheater tubes. The headers are arranged transversely to the boiler and are supported in a casing D in front of the uptake E, just above the level of the smoke-box F. The



coils of the superheater tubes are arranged in vertical banks, the several banks being spaced apart a distance equal to the horizontal pitch of the boiler smoke tubes G, G, and preferably so arranged that they are suspended opposite the spaces between the said boiler tubes. That is to say, the gaps between the banks of superheater coils are linable with the boiler tubes. The several coils of each superheater tube are bound together by two or more metal bands H, H. (*Sealed.*)

110,372. London Electric Supply Corporation, Limited, London, and A. G. Fox, New Cross, London. Feeding Fuel to Furnaces. (2 *Figs.*) August 14, 1916.—This invention relates to means for feeding fuel to furnaces of the type in which the fuel is fed from the front to the rear of the grate by the movement of the grate itself. These grates are usually supplied with fuel by gravity through a conical hopper, and the thickness of the layer of fuel passing on to the grate is regulated by means of a guillotine type of door which is adjustable in a vertical

Fig. 1.

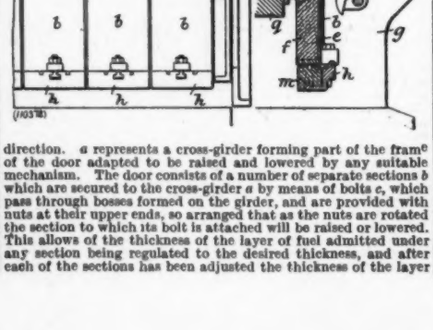


Fig. 2.

direction. a represents a cross-girder forming part of the frame of the door adapted to be raised and lowered by any suitable mechanism. The door consists of a number of separate sections b which are secured to the cross-girder a by means of bolts c, which pass through bosses formed on the girder, and are provided with nuts at their upper ends, so arranged that as the nuts are rotated the section to which its bolt is attached will be raised or lowered. This allows of the thickness of the layer of fuel admitted under any section being regulated to the desired thickness, and after each of the sections has been adjusted the thickness of the layer passing on to the grate under all the sections can be varied simultaneously by the same amount by raising or lowering the cross-girder. The individual sections of the door each consists of a main portion e of substantially rectangular shape, the interior of which is filled with some heat-resisting material f to prevent radiation from the furnace through the door to the unburned fuel in the hopper g. As the lower ends of guillotine doors are subjected to great heat through contact with the burning coal they rapidly become burned or otherwise destroyed in places, and one of the main advantages of making the door in sections is that one or more sections can be removed and renewed without having to replace the whole door. To still further improve the construction, each section is provided with a renewable nose-piece k clamped to the lower end and containing heat-insulating material m. The sections are pivoted to their adjusting bolts in such a manner that they are biassed by gravity to lean inwards, and horizontal projections o are provided on the rear side which make a rubbing contact with a vertical metal plate or lintel p, which is usually arranged between the brick combustion arch q and the furnace door. It will be readily seen that should the metal plate become distorted, as is often the case, the projections o on the individual sections will accommodate themselves and continue to be held in close contact with it, and prevent air from leaking into the furnace. At the same time jambing or stiff working of the door is avoided. (*Sealed.*)

TEXTILE MACHINERY.

110,475. H. Jones and Jones Brothers Textilities, Limited, Blackburn. Wire Heald Frames. (7 *Figs.*) March 6, 1917.—The invention relates to a wire heald frame wherein carrying rods are situated between the staves, and are supported by end straps in connection with the latter. a, a, are the ordinary staves connected together by straps b, for supporting the rods c, which carry the ordinary healds for the loom warps, a few of said healds being indicated. According to this invention, the abutment means consist of projections c^1 formed at the extremity of each rod c. These projections, by extending beyond the edges of the strap b, form abutments against withdrawal of

Fig. 1.

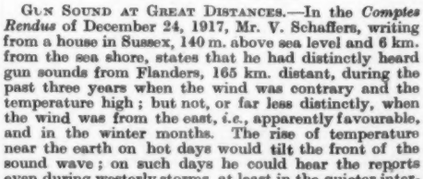
Fig. 2.

Fig. 3.

Fig. 4.

the rod c when the looped portion of said strap about the rod is pressed against the latter by the action of tightening means, such as the sliding-piece or clip b_1. The strap b may have a contour in the neighbourhood of the rod c such that the pressure of the clip, when raised or moved for locking a rod c in position, will cause the loop of the strap to clasp the rod in a tight manner, but on the movement of the clip $b1$ away from the part of the strap considered, release of pressure will result, as indicated in Fig. 4. For some such position of the clip $b1$ last indicated, the rod may be released or further released by the operation of springing apart the sides of the strap b forming the loop about the rod c, with the use of the fingers or an instrument. (*Sealed.*)

110,098. J. C. Stead, Yeadon, near Leeds. Shuttles. (3 *Figs.*) February 21, 1917.—This invention relates to an improved form of vibrating clip for securing the spindles in loom shuttles. According to the invention, the clip proper A of any ordinary type, which receives the spindle B, is formed with a pendant hollow cylindrical heel-piece C, parallel to the clip, which heel-piece C fits slidably within the bore of a small square box D fitted longitudinally within a slot E in the shuttle body.



The heel-piece C, closed at one end (see Fig. 1), is adapted to receive a small spiral spring F which controls the sliding or longitudinal vibrating movement of the clip within the box D, the closed end of the heel-piece abutting against a stop pin, and the spring abutting against a similar stop pin. The spring F absorbs all shock and concussion on the bobbin J in the direction of the nose of the bobbin, due to the picking and checking of the shuttle during weaving. (*Accepted October 17, 1917.*)

GUN SOUND AT GREAT DISTANCES.—In the *Comptes Rendus* of December 24, 1917, Mr. V. Schaffers, writing from a house in Sussex, 140 m. above sea level and 6 km. from the sea shore, states that he had distinctly heard gun sounds from Flanders, 165 km. distant, during the past three years when the wind was contrary and the temperature high; but not, or far less distinctly, when the wind was from the east, *i.e.*, apparently favourable, and in the winter months. The rise of temperature near the earth on hot days would tilt the front of the sound wave; on such days he could hear the reports even during westerly storms, at least in the quieter intervals. He also refers to the "mistpoffers," about which little has been said during the war years, but which were frequently discussed before the war. Particularly on hot, hazy days sounds, like reports of explosions in the far distance, were sometimes heard in the North Sea and in the Netherlands. The sounds of these mistpoffers were apparently not connected with gun practice or explosions because the distances in question were thought too great, and the wind was contrary. These recent observations would support the often-advanced argument, however, that what is doubtful is not the source of the sounds, but the mode of propagation of powerful sound waves through the air.